Engineering Record

A Weekly Journal Devoted to Civil Engineering and Contracting

Published by McGraw Publishing Company, Inc.

Volume 72 NEW YORK, SATURDAY, AUGUST 21, 1915 Number 8

The Galveston Storm

GALVESTON'S sea-wall was subjected to a severe test by the tropical storm which swept over the city on Aug. 16. To what extent the structure broke the impact of the huge waves which piled up against it and withstood their damaging blows is not known at this time, for telegraphic communication with the Texas city has been almost completely demoralized. Press reports, however, make no mention of any failure of the sea-wall, although certain portions of the city were said to be under several feet of water. The injury to structures along the waterfront, apparently, has been severe, but without the concrete wall it is fair to infer that the damage would have assumed much more serious proportions. The storm of last Monday is another justification for the measures which the city took to prevent repetitions of such disasters as the one of Sept. 8, 1900. For what degree of mitigation of the storm's fury the sea-wall was responsible Galveston has her engineers to thank.

Analysis of Indeterminate Structures

PRACTICAL engineers are apt to give little attention to elaborate methods for exact analysis of indeterminate structures proposed by the mathematician or the theorist. This may be due to either or both of two causes—inability to apply quickly a complicated mathematical method and the feeling that the fundamental assumptions upon which the theoretical analysis is based are not sufficiently exact to justify any claim for accuracy of results. While the description of the proposed accurate slope-deflection analysis of the wind stresses in the framework of high office buildings, given on page 231 of this issue, indicates that an appreciable decrease in the labor required for such analysis has been attained, this journal believes that the fundamental assumptions are not wholly unassailable. As stated by the authors, the assumption of absolute rigidity at the joints can be demonstrated only by tests, and none are available. Furthermore, the presence of knee-braces or solid web brackets at the columns would probably modify the theoretical relations appreciably, particularly in the effect on moments of inertia, on the unsupported length and on the position and nature of the end moment. The further effect of solid walls and interior partitions in resisting wind loads, of the floor slabs in modifying the lateral deflections of columns in adjacent bents, of unequal temperature deflections, not to mention the large relative error in the assumed wind pressure itself, all make exact stress analysis impossible. While such extended theoretical studies are of value in showing which of our approximate methods are probably best, for daily application these mathematical theories, even when simplified by approximations, are evidently not justifiable for ordinary practical design unless assumed conditions are closely realized.

Boston's Newest Tubes

THE location of a section of the Dorchester tunnel under the Fort Point Channel in Boston was purposely made to escape easements that would have been necessary if the obvious plan of running under the city streets and crossing the river at right angles had been adopted. At first sight this selection would seem to invite trouble, as it involves driving two tunnels for a long distance in water-bearing ground with relatively thin cover, as described on page 218. The engineers' confidence in borings which indicated that the ground was most favorable for tunnel driving with compressed air, however, is being justified. The soil is relatively stiff, and not subject to blow-outs. To further reduce danger from this source, the shields were provided with the sliding platforms used in driving open tunnels in soft ground. These platforms can be employed to help hold the working face, so that excessive air pressure need not be carried. To increase the economy of driving another method adapted from open tunnel practice is to be used. Belt conveyors will carry spoil from the shields back 100 ft. and deposit it in muck cars. This clear space behind the shields will be used to carry on the operations of waterproofing and concreting. For this latter work, sectional steel forms mounted on a carriage that rolls on the finished invert, and that clears the belt conveyors and the concrete cars, are being used. Another feature of this work which will be watched with interest is the use of wood block as against cast-iron segments for the outer lining. It is thought that these blocks will be placed with the ease and speed of pressed steel lining, while they furnish a direct surface for waterproofing, which can thus be put in its logical place, outside and not inside the concrete lining.

Graphic Standards Proposed

TO SECURE uniformity in the graphical presentation of data a number of associations of national scope have appointed representatives to serve on a joint committee which is making a study of the methods used in different fields for converting statistical matter into the form of curves and diagrams. While the membership of the committee is not confined to engineering organizations, three of the national engineering bodies are represented, the chairman being Willard C. Brinton of the American Society of Mechanical Engineers. The committee's work, apparently, has two main objects: First, to promote a more general use of the graphic method of presenting facts, and, second, to standardize the form of presentation. Among engineers the value of curves for illustrating the relationship between variable factors is so well appreciated that it is reasonable to assume that an educational campaign for graphic presentation will be directed chiefly to other fields. In the matter of standard forms for diagrams, however, engineers will find a great deal of timely and profitable information in the committee's preliminary report, which was issued last week. The object of curves is to render complex information susceptible of quick and accurate interpretation, and if the use of certain basic principles in the plotting of diagrams can be made general the value of the graphic method will be greatly enhanced. Although most of the fundamental principles which the committee enunciates are not new, they will bear repetition. The general arrangement of a diagram should be from left to right. The zero line should always appear even if it is necessary to make a horizontal break and close up the two sections of a diagram which would otherwise be of excessive vertical height. In curves involving percentages the 100-per cent line should be emphasized. Curve lines should be sharply distinguished from co-ordinate rulings, and in no case should the co-ordinate lines be closer together than is necessary to guide the eye in recording the diagram. But the final suggestion of the committee is, possibly, the most important. It makes a plea for a clear and complete title to every diagram, and this recommendation deserves hearty support. Engineers are so prone to neglect this point, not only in diagrams but in all forms of detail drawings, that it cannot be emphasized too strongly. In printed matter or reports diagrams or plans often are remotely separated from the text discussing them, and it is essential that they be labeled in such a way as to leave no doubt as to their subject. The committee has a large task before it, and if its mission is to be fulfilled it must receive co-operation from those whom it is striving to serve.

Expense Accounts at Conventions

NEXT MONTH there will be an opportunity for many small cities to make profitable investments. The New England Waterworks Association will hold its annual convention in New York, Sept. 7, 8 and 9, and, if past meetings of this society are a criterion, the occasion will offer to waterworks engineers an unusual opportunity for absorbing information of a decidedly useful nature—information which can be applied directly to the conduct of their work at home. In the small town, however, the waterworks superintendent does not always receive a salary which will allow him to bear, without considerable sacrifice on his part, the traveling expenses and hotel bills incident to attendance at a convention. And so, often, he is compelled to forego a trip which would benefit not only himself but the town he serves. Under such circumstances the city will do well to pay the convention expenses of its representative. Laymen, unfamiliar with meetings of reputable engineering organizations, are prone to regard them as mere junkets, but happily these opinions are fast losing ground, for the good work of associations, such as the New England, is making itself felt throughout the country. The waterworks convention offers to engineers and superintendents a common meeting ground where they can exchange experiences and profit by learning of the successes and failures of their fellows. The small town engineer is the very man who needs this broadening influence. Progress is making rapid strides in the waterworks field, and the city which fails to apply these improvements to its own works follows a short-sighted policy which will soon place a needlessly heavy financial burden upon the shoulders of its taxpayers. It is true that the waterworks superintendent may learn of developments in his profession through the medium of books, society proceedings and the technical press, but these sources of information should supplement, not supplant, the knowledge gained by attendance at engineering meetings. For at such gatherings it is possible to receive, informally, advice on important subjects which, for many reasons, may never make its appearance in print. Then, too, there is the exhibit of waterworks equipment and appliances, nowadays an education in itself. All of the newest cost-saving and labor-reducing devices are on display. The engineer who has had an opportunity of investigating all of the manufactured products in a particular line is best qualified to save his city money in the purchase of equipment, for he is in a position to discriminate intelligently as to what will best serve its needs. The convention offers to him this opportunity. Let municipalities, therefore, send their waterworks' officials to the New York meeting. The cost will be returned to them manifold.

Wane of Speculation Helps Colorado's Irrigation Situation

IRRIGATION projects in Colorado and many other Western States are passing from the promotion stage into a period of completion and fruition and, in consequence, little of a spectacular nature is being said or done. The optimistic irrigation land promoter has long ago passed on to more fertile fields. There is little opportunity for the locating civil engineer. Settlers and town-builders are needed now. The operating engineer and the municipal engineer are transplanting the constructing engineer and contractor.

This settling up period is a trying one for all concerned, particularly the investors, who always feel that the process is going too slowly. It is going slowly, but steadily, for that is the way practically all successful irrigation projects have grown. Those in Colorado who are in a position to know feel that the natural laws of growth are being followed at present and that on the whole matters are better than they are usually pictured. Of 4,000,000 acres irrigated or planned under irrigation systems, projects representing not more than 500,000 acres are in trouble, and most of these will probably be successful eventually.

John E. Field, in his latest report as State engineer, observes that the exact situation, particularly to those who have become unfamiliar with conditions during the last two years, is little known. As compared with the activity of five or ten years ago, quiet reigns, and on that account the casual observer concludes that development has ceased, and some individuals, especially among financial interests, consider it discredited. Summing up the situation, Mr. Field says:

"Speculation has been practically eliminated both in the development of projects and in the purchase of lands. In the elimination of the speculator and the investor who never really intended to move upon the land himself, a very considerable amount of land has been thrown upon the market, so that to-day one may obtain choice tracts for very reasonable figures, much less than their intrinsic value.

"Those irrigation enterprises which had not been financed and had not reached the construction stage, one might say, have been discarded for the present, perhaps wisely so, because in almost every period when there was a large development in irrigation construction has been several years ahead of the necessities, with the result that they were not profitable to the originators.

"On those projects which were under construction, or which had been financed, the efforts of the builders have been directed to putting the enterprise on a paying basis, insuring revenue and payment of interest and maintenance. Many of the projects have been changed and only certain portions finished, the idea being to finish in units and settle each unit before another was undertaken.

"On some projects having considerable merit, although not financed, reorganization has been attempted by making the development a mutual enterprise, eliminating the profit of the promoters and builders. The cost, whatever it may be, is to be distributed on the acreage basis equally. The owners of the land in control elect their own officers, direct their own work on new organization and pay the old organization the value of the work actually accomplished. This, of course, included investigations and surveys. During the past two years the efforts on old irrigation projects have been directed to increasing the efficiency, and, where actual experience has demonstrated that during dry years and dry periods the water supply has been insufficient, in obtaining better water supplies.

"The period is also marked by another condition—there are not enough settlers on the land as yet and the percentage of land irrigated under the new settlers is hardly sufficient to pay the interest charges and maintenance. During the past year those in control of the various enterprises have realized this condition and are making extra effort to get settlers of a permanent character. The speculative element is discouraged and the non-resident holder is not considered desirable."

Why the Western Rate Decision Is Disappointing

DISAPPOINTMENT in the decision of the Interstate Commerce Commission in the Western rate-advance case is softened only by the dissenting views of Commissioners Daniels and Harlan. Instead of asking for a horizontal increase, as the Eastern roads did last year, the Western roads selected certain commodities, mainly carload commodities, which they held were not contributing their share, and asked for specific increases thereon. A few of the advances are granted, but most of them are not, and the increase in revenue is estimated by Mr. Daniels at a paltry one-fourth of one per cent. Quoting from Mr. Daniels: "In the essential outcome of the majority's report I am unable to concur, believing that on the record the carriers have in general sustained the burden of proof cast upon them by the statute and are of right entitled to increases in rates productive of revenue far in excess of what they are accorded by this decision." After showing a disposition in the latest Eastern rate case to give the railroads occasionally the benefit of reasonable doubts, the commission now invokes the doctrine (quoting again from Mr. Daniels) "to disallow increased rates save where the specific evidence relating thereto makes a refusal manifestly impossible." Mr. Daniels characterizes this as a novel doctrine invoked for the first time. This journal does not regard this attitude as novel, but rather characteristic of the Interstate Commerce Commission in handling recent rate cases. It agrees with Mr. Daniels, however, that "the failure to follow established premises to their legitimate conclusion only beclouds the principles upon which the commission may be expected to act in future, and leaves nothing certain but uncertainty."

On another point Mr. Daniels thinks the commission has gone astray, and that is in penalizing all of the railroads for the mismanagement of a few. He thoroughly condemns the wrecking of such systems as the Rock Island and the Frisco, but suggests that the remedy is the prosecution and punishment of the individual offenders. He compares railroads with banks. He reminds us that the bank official who misapplies or misappropriates funds can do so only under the shadow of the law, and that no one would seriously suggest that banks generally should be prevented by law from raising the rate of discount in case competitive conditions warrant, merely because there have been banking defalcations.

In summing up the situation, the Engineering Record can do no better than to quote Mr. Daniels' concluding paragraph: "In the matter of rate regulation and fixation we have reached a point where one of two courses ought deliberately to be chosen and clearly announced. If, despite increased costs not offset by increased revenue, increases in rates are to be denied, except where, in individual instances, gross injustice would be occasioned by their denial, the carriers ought to be apprised of this policy, so that they may set their house in order, if they can, against such a situation. If, on the other hand, we are to acknowledge in general what we are perforce compelled to admit in detail, just and reasonable increased rates should be permitted, not grudingly, but with such fair measure of allowance as will indicate that the transportation industry is entitled in the interest of the public to earnings sufficient to provide a service commensurate with public needs."

Trend of Laws Affecting Labor

In these days every man must be his own lawyer or have counsel at his elbow most of the time. This reflection is emphasized by an examination of the "Review of Decisions of Courts Affecting Labor," recently published by the Bureau of Labor Statistics. On nearly every page of this useful book there is information of value to employers of labor and especially to those engaged in construction work.

Noted more or less at random are decisions holding unconstitutional an Oregon statute requiring union labor to be employed and fixing the rate of wages at $2 per day; placing in a like category an Illinois law which undertook to permit a subcontractor to secure a lien the same as a contractor; and holding, in a North Carolina case, that the incompetence of a fellow servant was the cause of liability of the employer, a workman assuming the risk of negligence of his fellow servant, but not of the negligence of the employer in selecting incompetent employees. Another case, the knowledge of which might save a contractor a lot of money, was one decided under the New York employers' liability law holding that the duty of the employer to furnish a safe and proper scaffolding was not delegative. Evidently it is not safe to put incompetent employees into positions where their ignorance may endanger others or to assume that having delegated the building of a scaffold to another, liability may thereby be escaped.

This view again emphasizes the fact that we are living under a new dispensation so far as workmen's compensation laws and their interpretation are concerned. "In course of his employment", as construed in various States, means that a Wisconsin employer is liable for injuries incurred by an employee while on the way to the place of his employment; that a Michigan employer is liable for injuries sustained by a man running to punch the time clock when the noon whistle blew; and that under the same law a workman leaving a roof for luncheon at the invitation of his employer, and injured while coming down by a way of his own choosing, is "within the protection of the act," although other workmen came safely down from the roof by another route. Rulings on the subject of extra-hazardous employment go so far as to hold that a carpenter engaged in putting up shelves in a store and attempting to sharpen a chisel in a workshop belonging to another was engaged in an extra-hazardous occupation. The Washington Industrial Insurance Commission held to the contrary and was reversed by the supreme court of the State.

In another category entirely, but no less illuminating as to the trend of decisions affecting labor, was the decision of the appellate division of the supreme court of New York ruling on the effect on individual contracts of a collective agreement made by a labor union. It was decided by the court that a collective agreement was of such validity as would support recovery of the difference between the amount stipulated therein and the employee's wages under a contract made in ignorance thereof.

What Railroad Freight and Passenger Service Cost

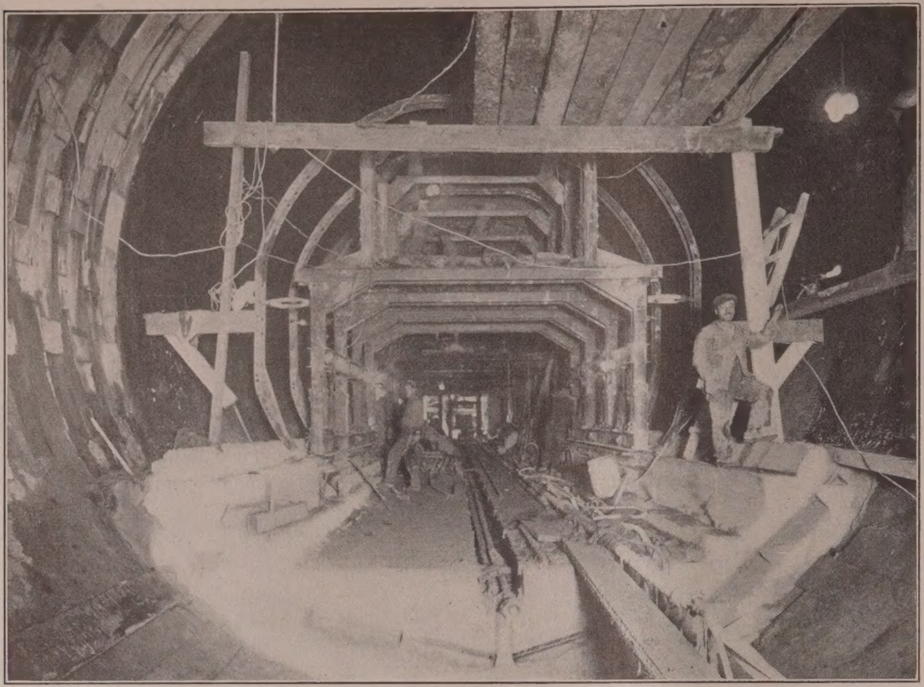
Beginning on page 226 of this issue the Engineering Record gives three pages to what it considers a most thoroughgoing and unusual effort to apportion the cost of running a railroad among the different classes of service and determine not merely whether the traffic as a whole is earning enough, but whether a certain large part, the passenger traffic, is bearing its share of the load.

Doubtless there are some engineers, whose tastes run to highly technical studies, who will question the appropriateness of such an investigation in these columns. It is true that, in general, the engineer cannot concern himself with the details of rate-making. It is also true that such a division of expenses and investment as Mr. Wilgus has produced is largely a matter of bookkeeping. It is equally true, however, that maintenance, which is strictly the province of the engineer, is a vital element of railroad operation, the cost of transportation and, therefore, the rate, and that every-day railroad accounting is frequently botched by bookkeepers who do not appreciate engineering and by engineers who do not appreciate bookkeeping. This journal commends the Ulster & Delaware for putting its passenger-rate investigation in the hands of an engineer of Mr. Wilgus' experience, and believes every railroad man will find a careful reading of that investigation instructive.

Some members of the committee on economics of railway location of the American Railway Engineering Association have been striving to make a start toward determining scientifically the relative destructiveness to permanent way and structures of passenger and freight traffic. These engineers will, perhaps, be disappointed at the way Mr. Wilgus has cut the Gordian knot. Two or three years ago the committee suggested, more for the purpose of arousing discussion than because of any firm conviction, that a passenger ton be figured twice as destructive as a freight ton. The whole matter was referred back to the committee after wide differences of opinion had been expressed on the subject, and although the question was conceded to be very important, and the committee was instructed last year to make special efforts to collect information thereon, no further recommendations have been ventured. And now Mr. Wilgus simply equalizes the two classes, believing that drippings and droppings, imperfections of equipment, heavier wheel concentrations and numerous other items peculiar to freight service are enough to offset the greater speeds and impacts of passenger trains. There is some question whether Mr. Wilgus has not proved his point too well—whether some railroad men will not now conclude that the freight ton should have the multiplier.

The foregoing is a question applying only to maintenance of track and structures, one item among many in Table 2 of the abstract on page 226. The entire table, as well as the other tables setting forth the several different methods of allocating properly the various items of railroad expenses, merits close examination. Many items are readily separable into the two main classes of traffic. The ton-mileage basis, with or without a multiplier to put freight and passenger tons on the same footing, is undoubtedly best for the track structures actually worn down by traffic. On the other hand, such items as fences, signals and the removal of snow and ice are incidental to the operation of the railroad as a whole. The heavy or fast train affects them no more than the light or slow one, and the proper basis is evidently the train-mile. The same is true of the dispatching of trains. Under the different main heads are various miscellaneous items, and these Mr. Wilgus allocates in the same proportion as the sum of the other items under that head, while the subhead "general expenses" he subdivides according to the average of all other expenditures. For the maintenance of equipment he uses the mileage of the unit, but when he comes to analyze the so-called passenger traffic itself he uses still another unit, the car-foot-mile, as the weights of contents are negligible and the costs of mail, express and passenger service are indeed approximately according to the car-foot mileage.

Tables 5, 6 and 7 are of interest mainly as showing the generally low rate of return on the entire property and the disproportionate sharing of running expenses by the different kinds of traffic. Mail and express are carried at a dead loss, but the most disquieting disclosure is that if the traveling public saw fit to avail itself of mileage tickets it could compel the railroad to haul it at nearly 15 per cent below cost. The New York Public Service Commission has decided that it lacks the authority to grant the increased rates that would produce the modest net returns set forth in Table 8, but surely compelling a railroad to sell transportation actually below cost is an economic anomaly that cannot long continue.



STEEL FORM IN SECTION WATERPROOFED AND READY FOR CONCRETE LINING

Belt Conveyors Will Help Simultaneous Driving and Lining of Air Tunnel

Tubes Under Old Point Channel for Dorchester Tunnel in Boston Driven by Shields Having Sliding Tables to Hold Working Face

By G. D. EMERSON
Division Engineer, Boston Transit Commission

BELT CONVEYORS will be used in driving the Dorchester tunnels in Boston to carry clay spoil from the shields back 100 ft. through the concrete forms to muck cars, so that the operations of driving, waterproofing, and lining the tunnels can proceed simultaneously. To avoid expensive easements the tunnels were located under the Fort Point channel, where the ground was excellent for tunnel driving. They are being built under compressed air with shields which have two working platforms, thrust forward by hydraulic jacks to help hold the face. Behind these shields is placed wood block segmental lining.

LOCATION OF TUNNELS

The Dorchester tunnels are among the newest routes of Boston's underground transportation system. They begin with a direct connection to the Boston terminal of the Cambridge subway at Tremont and Winter Streets, run under Winter and Summer Streets, the Fort Point Channel, and Dorchester Avenue to Andrew Square, Dorchester, a total length of a little more than 2 miles. Section E of this route, some features of which are described in this article, includes the portion under the Fort Point Channel and private property between Summer and West First Streets, a length of about 3200 ft., of which 2160 ft. is directly under the channel, and the remainder under streets and private land. The Fort Point Channel is a somewhat irregular navigable waterway connecting Boston Harbor with a tidal basin called South Bay. Construction has been in progress on this section for several months.

The location of the portion of the route included in Section E, under the middle of and parallel with the channel, as shown on the accompanying plan, was governed by the locations of the adjacent tunnel stations and the opportunity of avoiding expensive takings in private property. The maximum grade established for the tracks of this route is 3 per cent, and the minimum radius of curvature 500 ft.

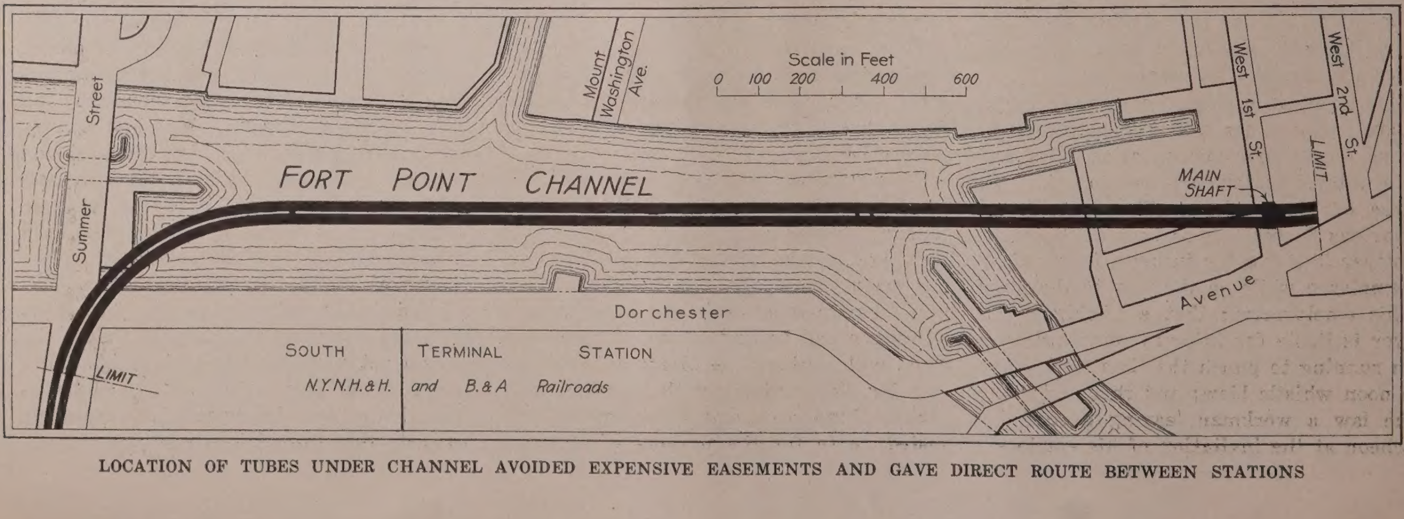
NATURE OF SOIL FAVORABLE

The tunnels will be built largely through a fairly stiff blue clay. Near the northerly end borings indicate occasional pockets of sand, with hardpan near the bottom. The minimum depth of the top of the tunnel under the channel is 35 ft. below mean low water, except at its northerly end, where, in a length of 300 ft., its depth is decreased from 35 to 25 ft. The minimum thickness of earth cover between the top of the tunnel and the bottom of the channel is about 15 ft.

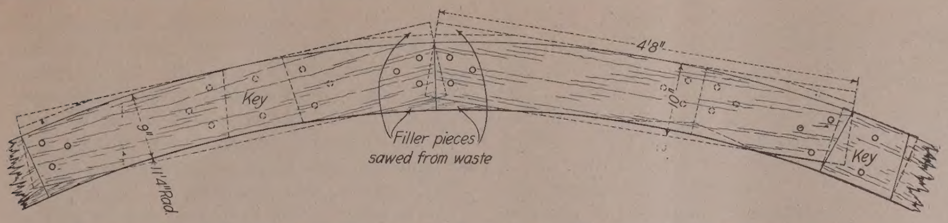
There are two parallel, circular, shield-driven tunnels, each accommodating a single track. The circular shields have an external diameter of 24 ft. 4½ in., and are 12½ ft. long. Each shield is equipped with twenty-four 8-in. hydraulic rams, each with a maximum working pressure of 5000 lb. per square inch. The forward ends of the shield decks are fitted with sliding platforms. The platform of each deck is divided into two sections, each section being operated by two 86-in. hydraulic rams. While excavation in the shield is in progress sufficient pressure is exerted continuously by the platform rams to keep the front edge of the platforms pressed against the earth, thus providing two horizontal lines of support for the working face. The main shield rams react against the end of the outside wooden lining when shoving the shield forward, the ram heads being shaped so as to distribute the pressure over nearly the whole end area.

SEGMENTAL WOOD LINING USED

The outer shell of each tunnel is made of Southern longleaf pine, 9 in. thick, with an external diameter of 24 ft. 2 in., and is built up of segments accurately sawed to shape, each segment being about 4 ft. 8 in. long and 9¾ in. wide. Sixteen segments and a key-piece complete each ring. The wood segments are put in place in the tail of the shield in about the same manner as the commonly used cast-iron ones, but on account of their lighter weight they are erected by hand. The segments of each ring are fastened to the preceding ring by means of ½-in. steel pins. There are three pins in each end of each segment. The pins, which are 15 in. long, are in-



LOCATION OF TUBES UNDER CHANNEL AVOIDED EXPENSIVE EASEMENTS AND GAVE DIRECT ROUTE BETWEEN STATIONS



LINING BLOCKS SAWED ECONOMICALLY AND MADE TO GIVE SMOOTH SURFACE

serted in holes previously bored in the segments before being erected, and when each segment is in position the pins are driven into the next ring behind by means of the shield rams. The ends of the segments are chamfered on the inside, as shown in the illustration, so that they may be cut from smaller sized timbers, thereby considerably reducing the amount of waste lumber. The irregularities thus left in the inside surface are filled in with wedge-shaped fillers in order to provide a smooth surface on which to apply the waterproofing.

Before placing the interior concrete lining a waterproofing membrane is applied to the interior of the wooden shell. This membrane consists of layers of a treated cotton fabric mopped with hot asphalt. Two layers are put on the invert and three on the sides and arch. In applying the waterproofing to the sides and arch the first layer of cloth is mopped on one side with asphalt and is then nailed to the wood lining with roofing nails, the mopped side being against the wood. The second and third layers are then stuck on with successive moppings of hot asphalt.

The inside concrete shell has a minimum thickness of 2 ft. and is unreinforced. Blaw steel forms are used for concreting the sides and the arches. These forms are made up in 5-ft. panels and are handled by means of a traveler running on steel rails laid on the invert. The traveler is 15 ft. long and carries three form panels at one time.

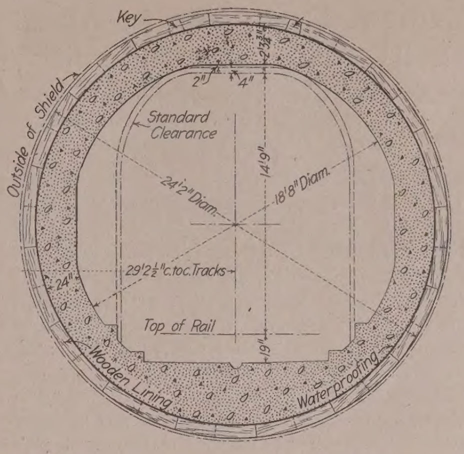
In each tunnel there are two horizontal muck-locks each 50 ft. long by 7½ ft. in diameter, and one man-lock 30 ft. long by 6 ft. in diameter.

The excavated earth is hauled out of the tunnels in 1½-yd. side-dump steel cars. Both muck and concrete cars are at present being hauled with drag-lines and compressed-air winding engines. When the shields get some distance away from the locks it is the contractor's intention to substitute small electric mine locomotives for the drag-line. Temporarily the muck cars are being loaded by hand at the rear of the shields, but later belt conveyors will be installed which will carry the earth back about 100 ft. from the shields, where it will be plowed off into muck cars on either side. This arrangement is expected to do away with any interference between the operations of handling the earth and waterproofing and concreting the tunnel linings.

The main shaft, the bottom of which is about 60 ft. below the surface, was excavated in free air and the shield for the easterly tunnel was started without compressed aid and was advanced without difficulty for about 180 ft. from the shaft, when the clay suddenly began to flow in at the heading faster than it could be taken out. Excavation was stopped at this point until the air locks could be installed and the tunnel put under compressed air. The same thing happened in the westerly tunnel when its shield had advanced about 100 ft. from the shaft. The depth of earth over the top of the tunnels at this point was about 35 ft.

SHIELDS EASILY CONTROLLED

No difficulty has been experienced so far, except during the first few weeks when the tunnel men were getting acquainted with somewhat unfamiliar duties, in keeping the shields within a couple of inches of the true line and within about an inch of the proper grade. The homogeneous character of the ground makes the control of the shields comparatively easy. The alignment of the shields is checked once or twice a day with a transit and the elevations are checked once a day. Between checks the grade is controlled by an ordinary carpenter's level, which, in plan, is set parallel to the axis of the shield and in elevation is pivoted at one end and at the other is clamped to a short arc. This arc is graduated so that when the level bubble is brought to the center the graduations show the per cent pitch of the shield up or down, as the case may be. For example, if the grade of the track is 3 per cent down, and the shield is kept at a pitch varying from 1.8 per cent in free air up to 2.5 per cent with an air pressure of 20 lb. gage, it will follow very closely the 3 per cent grade of the track. Any change in the character of the ground will, of course, introduce another variable into this adjustment.



WATERPROOFING IS OUTSIDE OF CONCRETE

WOOD BLOCKS, PLACED IN TAIL OF SHIELD, FORM OUTER LINING OF TUNNEL

COST AND PROGRESS

The average progress at present is from 10 to 12 ft. per day, although the working force is not yet completely organized, and a daily progress of from 12 to 15 ft is expected after the belt conveyors are installed in the tunnels.

The contractor's bid for the 3200 ft. of double tunnel is $1,955,375. This figure is the sum of unit price items and covers practically all costs except engineering, administration, interest, and land damages.

The Dorchester tunnels are being constructed for the City of Boston by the Boston Transit Commission, of which Prof. George F. Swain is chairman, E. S. Davis chief engineer, and the writer division engineer in charge of construction. The contractor is P. McGovern & Company. Charles R. Gow is consulting engineer and A. A. Cohill superintending engineer for the contractor.

STEAM SHOVELS BURN NATURAL GAS in the construction of a remote part of the Ridge road in southern California where the gas mains from the oil fields passed near heavy excavation. Burners that would give satisfactory combustion were found after some experimenting, and 180-lb. normal pressure in the gas mains is cut down to about 10 lb. at the burners by a reducing valve. The gas company sells the gas to the contractor at a flat rate per shovel. The shovels used are a Bucyrus 60 and a Marion 31.

Cement Drain Tile in Alkali Soils Tested for Durability

Report on First Year's Investigation by R. J. Wig and G. M. Williams Shows That the Richer Mortars Withstand Disintegration

RESULTS of the first year's observations in a series of investigations being conducted by the U. S. Bureau of Standards for the purpose of determining the effect of the strongly alkali soils and waters in arid regions of the Western part of the United States upon cement mortar and concrete have just been reported by R. J. Wig and G. M. Williams in Technologic Paper 44. Because of the direct economic importance of tests on tile, the investigation was started by exposing various cement mixtures in the form of drain tile. As there are few known deposits of clay available for the manufacture of satisfactory clay tile in the regions where alkali soil is found, while materials for cement tile are usually close at hand, the value of reliable information regarding the permanency of cement tile can be realized.

Many engineers believe that well-fabricated concrete will not disintegrate when exposed to alkali salts and that many cases of failure which have been reported have not been caused primarily by the alkali, but resulted from the use of poor aggregate, improper methods of fabrication, or other causes which result in a poor quality of concrete.

Previous Investigations and Field Survey

A laboratory investigation was started in 1908 by the Technologic branch of the U. S. Geological Survey to determine the effect of alkali waters on cement and concrete. Briefly, these investigations showed that practically all cements are attacked by alkali waters upon exposure in the laboratory and complete disintegration can be obtained under certain conditions. Similar investigations have been made by other laboratories with similar results. Laboratory tests, however, must always be interpreted with caution, as conditions often differ somewhat from service, and it is on this account that a field investigation was undertaken.

The Bureau of Standards has made a field survey of concrete structures exposed to alkali waters in several of the Western States. A description of five of the structures which were examined will serve to illustrate the conditions found: 1. A small concrete "turn-out" for irrigation water, built about 1907, showed one portion completely disintegrated, while another portion is sound, the sound portion being a beam on the lower side extending into wing-walls exposed to the earth at each end, and located half above and half below the concentrated alkali waters. 2. The lower end of a small concrete gate culvert was found badly disintegrated, alkali salt being visible on the surface of the soil surrounding the lower end. 3. The concrete wing-wall of a large culvert was cited as a case of disintegration due to alkali salts, but upon investigation it was found that during flood the creek carried heavy boulders against the wall. Alkali salts visible in the pores of the eroded surface indicate that the alkali is present, but probably incidental and contributory rather than the initial cause of disintegration. 4. A large railroad culvert with a portion of an old concrete structure in the foreground was examined. The latter was completely disintegrated, so that it could be torn apart with the fingers, and alkali salt was found in the pores. The newer culvert, about eight years old, appeared sound and normal with the exception of a few spots near the ground line. 5. A small concrete retaining wall coping was found disintegrated, the surface of the surrounding soil showing the presence of alkali salts.

Field Tests Instituted

It is practically impossible, according to the authors, to analyze some of the failures which have occurred and state definitely the part played by the alkali salts. It was therefore deemed desirable to make field tests in which concrete of known composition and fabrication would be exposed in some of the worst known alkali districts in the West. A committee was organized and finally developed a program which required the manufacture of about 8800 cement drain tile made up of sixteen different varieties. The proportions of cement and sand varied from 1 : 1½ to 1 : 4.

The tile were made under contract at a commercial tile plant, the Armstrong Cement Works of Armstrong, Iowa. Both hand-made and machine-made specimens were used, and the curing was either by sprinkling or by steam. The tile were installed in operating drains on eight projects in the most concentrated alkali soils available in the West, and, for comparison, on projects where there was practically no alkali.

Tests and Results

The first physical tests of the tile were made in 1914, about one year after the tile were placed, by a small portable hydraulic testing machine. The results are generally quite uniform and compare favorably with other tests of drain tile. Occasionally results of tests of similar tile differ by 30 or 40 per cent, but usually they agree within a few per cent.

Notes were made on the length and thickness of the tile at each end, and its condition if in any way abnormal. Some of the tile which had a normal or slightly reduced strength showed evidence of alkali action by sharpened edges or cracked surfaces. Where such action has been noted it is possible another year or two of exposure may cause the failure of the tile, although this need not necessarily result.

Conclusions

Special care should be observed in the use of cement drain tile to employ only the best materials and good workmanship in its fabrication. If these precautions are not observed, failure will result if the drain is located in some of the more concentrated alkali soils similar to those found at Grand Junction, Col., and Garland, Wyo.

Drain tile of cement mixtures not leaner than 1 : 3, manufactured as described, are apparently unaffected structurally when exposed for one year in operating drains in very concentrated alkali soils similar to any of those included in this investigation. Cement mixtures leaner than this should not be used for drain tile in localities where the character of the alkali and concentration are similar to that found at the sites of drains mentioned above. It is possible that subsequent results will show that no leaner mixture should be used in any district where appreciable alkali is found.

Drain tile, manufactured as described, of 1 : 4 mixture (the leanest used) is apparently unaffected structurally by exposure of one year in an operating drain in localities where the character of the alkali and the concentration are similar to those found at Fort Shaw, Mont.; Sunnyside, Wash.; Yuma, Ariz., and Roswell, N. M.

It is anticipated that this report will be amended from time to time as later results are available.

Erection at Hell Gate Arch Checks Calculations

Operation of Stressing Upper Backstays Brought Out Accuracy of Fabrication—Boom Mounted on Rear of Traveler Sets Upper Ties

THE ACCURACY of fabrication and erection at the Hell Gate bridge of the New York Connecting Railroad, New York City, was strikingly brought out by the operation of raising the saddles under the top set of ties on the Long Island side to bring the weight of the cantilevered arch panels on them. This operation raised the outer end of the arch section and inclined the end post toward the pier, loosening the lower set of ties, which were attached to the top of this post, and permitting their removal. A lift of 19⅝ in. applied to the saddles of the upper set of erection ties put the lower set of eye-bar ties in compression. The calculated lift to loosen these ties was 19½ in.

The erection of the arch trusses for this bridge over the East River is taking place by the cantilever method. The backstays of both sides have been devised from plate girders to be used in the approaches, and the floor stringers and other parts of the arch bridge have been utilized for towers, struts and bracing of the backstays, so that little extra material is required in the erection.

After the pins in the lower set of erection ties were removed, and the 2400-ton jacks had raised the upper saddle farther than the required 22 in. above the elevation at which jacking began, the pins in these ties were found to be within ⅛ in. of their calculated elevation. The final jacking raised the east part of the arch, which hinges about its abutment pedestals, so that it will meet the west half at the right elevation for making the closure. The jacks on both sides of the river will be lowered together in making the closure, and before the 22-in. drop is finished the two ends of the arch will fit together, all the deformation stress from dead load compression will be taken up, and the upper erection ties will be relieved of stress. With the members being built out into space accurately to height and direction as previously determined and constantly checked with a special transit for this purpose, it is expected that the arch ribs will come to an accurate closing with the compression stresses in the key pieces as predetermined. The erection stresses computed in the office of the chief engineer are measured during erection with Howard strain gages, and it can be recorded that the computed and the actual measured erection stresses show close agreement.

Reduced Uplift on Anchorage

During the operation of transferring the stress to the upper ties on the Long Island side, the behavior of the anchorage was carefully watched. The lower ties put a much greater uplift on the anchorage than the upper set. The anchorage had been weighted accordingly, and when the stress was transferred to the upper ties, it was feared that the reduced uplift would allow too much weight to come on the footings under the anchorage and that settlement might result. This, however, did not occur, and it was not necessary to remove from this anchorage any of the sand piled on it for weight.

After the lower ties were in place seven panels were erected with their support. The main traveler was then backed down to within reach of the backstay traveler, which mounted a boom on its rear end. The main traveler then moved out erecting with this boom the upper ties beyond the reach of the backstay traveler. When these were in place the rear boom was unshipped and laid on them. After the arch is swung the traveler will back down to the fifth panel, this boom will be shipped again, and the upper ties removed with it.

Operation Repeated at West End

The accompanying photographs, taken Aug. 10, show these operations in progress at the Ward's Island side. The backstay traveler is erecting the main post to carry the saddles for the upper ties, and the main traveler is being backed down to mount the extra boom on its west end.

After the upper ties on the west end are in place, erection of the balance of the arch across the river will proceed from both sides simultaneously by the methods outlined on page 586 of the Engineering Record for May 1, 1915. This work will be arranged so that car floats, on which all steel is delivered, will not have to be handled in mid-stream when the tidal currents are strongest, as it is likely that several tugs would be required to handle each float if this were attempted.

Special Falls for High Hoist

As the erection progresses over the river the arch rises until a vertical hoist of between 300 and 400 ft. is necessary to raise members from the car floats and set them. The main falls handle all members on a single hitch, and contain twenty-six parts of line each. To hoist 300 ft. with them would require drums that held a mile and a half of wire rope. Each fall is rove from the ends in, and has two lead lines, each wound on a separate drum. The combined capacity of these drums is only 7000 ft. of rope. To overcome the obvious difficulty, the lower block of the falls is made of two double and three triple blocks, the two doubles being mounted on the outside. The falls can be pulled to "two blocks," and the center triple block, or all three of the triple blocks, detached from the lifting beam and bolted by straps to the upper block of the falls. In the latter case, eighteen parts of line are left standing, while only eight overhaul with the lifting beam. These eight parts have a capacity of 80 tons, which will handle all the lighter members. The hoisting speed is more than tripled by cutting out the eighteen center parts, and only 1200 ft. of rope is overhauled by each drum in making a 300-ft. hoist.

Engineer's Report Blames Eastland Disaster on Poor Design, Overloading and Mishandled Ballast

Grand Jury Findings, Compiled by Prominent Structural Engineer Member, Recommend Eight Regulations—Dangers of Water Ballast Discussed

INSTABILITY of the steamship Eastland, the immediate cause of the disaster in the Chicago River July 24, was due to overloading with passengers, to mishandling of the water ballast or to the construction of the vessel. One, two or all three of these causes were responsible for the accident, according to the report and recommendations of the Grand Jury to the judges of the Cook County Criminal Court. Indictments for manslaughter have been returned against four officials of the owning company and against the captain and engineer of the ship for criminal carelessness in the handling of the vessel, passengers and ballast.

The compilation of the report was the work of Andrews Allen, consulting engineer, who, with an architect and a layman, were delegated by their confrères to reduce the findings of the jury to paper. Its conciseness, as well as the unusual character of the accident from an engineering standpoint, has led this journal to print the report, practically in full, below:

Findings of Report

The boat arrived at Clark Street dock and began to take on passengers *with no ballast in her tanks,* of which there were five on each side. She listed to starboard and the engineer started to fill port tanks 2 and 3. The passengers meanwhile were crowding onto the boat and when the load shifted so as to list the boat to port, the engineer attempted to pump out tank 3. When the boat did not right herself he shut down the pump and attempted to fill the tanks on the starboard side, but it was too late.

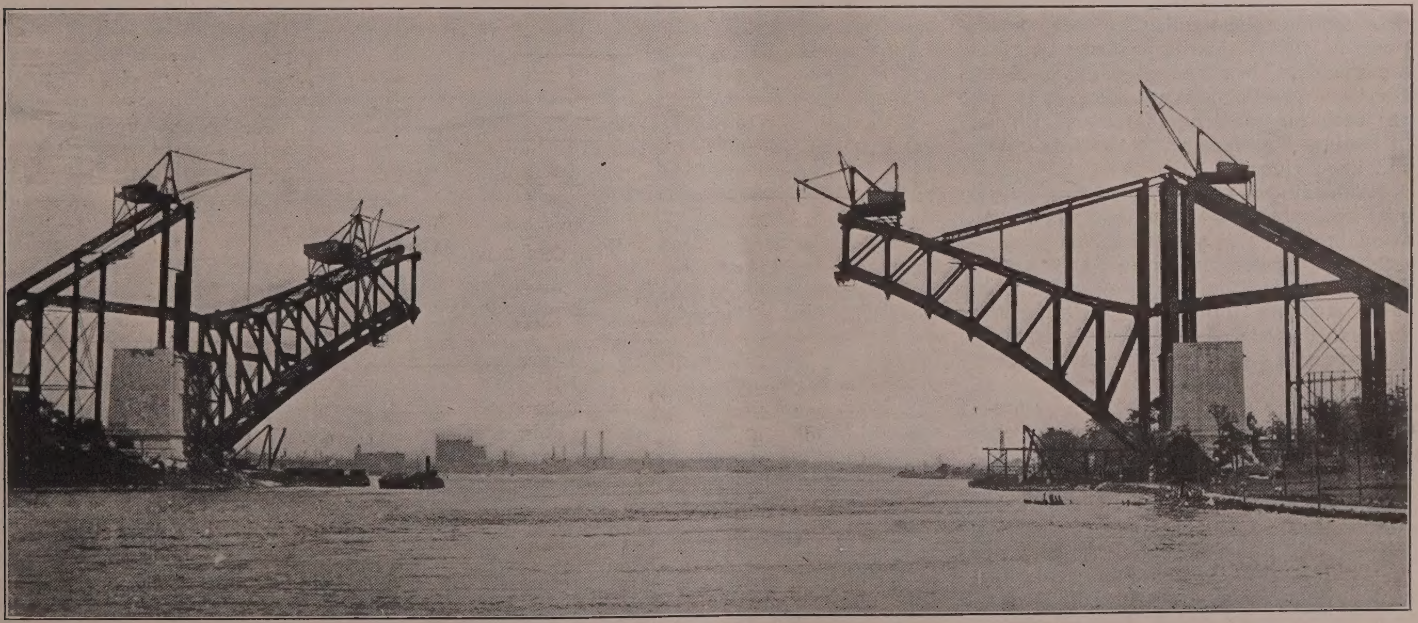
At the time of the accident the No. 2 port tank was filled or partially filled, No. 3 port tank empty or nearly empty, and No. 3 starboard tank just beginning to fill. That is to say, most of the ballast was on the port side, and two or possibly three of the tanks were but partially filled, so that the water could surge with every movement of the boat and produce a condition more dangerous than if the tanks had been empty.

The handling of the ballast by the officers of the boat indicates an entire lack of understanding of the nature and proper uses of water ballast, and an absolute disregard of safety after repeated warnings and frequent indications of extreme instability.

Design Faulty

The underlying cause of the disaster was the general construction of the vessel and that of her ballast tanks. The water ballast system was single, permitting the filling of the tanks from one seacock by gravity only, and made it impossible to empty some tanks while filling others, or to pump from one set to another. She was unsafe for passengers unless properly ballasted, and a very imperfect system of water ballast was used when *fixed ballast sufficient for proper stability* should have been required by the inspectors and owners.

As actually operated, with the tanks used for trimming purposes only, the safety of the boat at all times depended, *first,* on the quick wit and the judgment of the engineer and the captain; second, on the oper-



LOWER ERECTION TIES HOLD ARCH SECTION AT LEFT, WHILE WEIGHT OF THAT AT RIGHT HANGS FROM UPPER TIES ating condition of the valves, pumps, and seacock, any of which could have easily been clogged, and thus prevented the stabilizing of the boat.

The instability of this vessel, abundantly indicated by experience, would have been easily shown by calculation or by inclining test, and could have been easily corrected by means of fixed ballast. That it was not corrected years ago the jurors regard as indicating criminal carelessness or incompetence on the part of all persons connected in any way with the design, construction, control, operation and inspection of the steamship.

The fact that at various times, from the date of the construction of this boat to the time of the disaster, inspections were made by inspectors representing ship registry companies and insurance companies for the purpose of classifying said steamship Eastland for insurance purposes or vessel rating purposes, are additional contributory causes to this great disaster, and adds to the chain of careless, reckless and criminally negligent inspection of boats.

INSPECTORS INCOMPETENT

The Government inspectors had authority to refuse a permit to the Eastland until such changes had been made as would have made her seaworthy under all conditions of service. It appears, however, that the most important and fundamental question of stability was never investigated by the inspectors. The steamboat inspectors are generally not trained technical men, and are, therefore, not competent to make reliable stability calculations or to conduct inclining tests and to make competent calculations to determine the stability of the boat inspected by them under various loading and other service conditions.

The filing of plans of boats to be built or reconstructed has only been required in recent years, and the jurors were unable to get any plans at all of the Eastland. Such plans as have been turned in during the last two years have been used to determine only the character and strength of structures, machinery, boilers and appurtenances, have not been used except possibly in a visual manner to determine the stability of vessels.

RECOMMENDATIONS

In compiling the following recommendations, as well as in the preparation of the report, Mr. Allen had the advice of Col. Henry A. Allen, mechanical engineer, who has been representing the city of Chicago in its investigations as to the future tests and inspections.

1. The jurors recommended that no permits be issued until plans and calculations are submitted and approved.

2. That proper inspection be maintained during construction. Upon completion the vessel shall be subjected to inclining tests and calculations made from the tests to determine the safe load carrying capacity under service conditions.

3. That the stability of the vessel used in passenger service shall in no case depend upon movable ballast.

4. That water ballast shall be allowed for trimming purposes only, and when used the system shall be arranged with at least two seacocks with pipes cross-connected so that one set of tanks on one side can be filled while the other set is being pumped out, and so that water may be pumped from one set to another.

5. That all pertinent data relating to stability under service conditions shall be reduced to a convenient form and a printed copy containing necessary and desired information shall be posted in a prominent place in the pilot house of all vessels for ready reference by the officers of such vessels.

6. That definite regulations be issued by the Federal Government governing the carrying capacity of excursion and other passenger steamers, specifying the carrying of sufficient life saving equipment, passenger space, and limiting the number of passengers that can safely be carried, such loading to be based on the stability of the vessel under service conditions.

7. That the Steamboat Inspection Service be re-organized in a manner to make all branches co-ordinate and thus eliminate the confusion caused by the statutes delegating special powers and authority to subordinate branches. Such service should be provided with technically trained and experienced inspectors, all under proper systematic control.

8. That the Steamboat Inspection Service be transferred from the Department of Commerce and Labor and be placed under the control and direction of the Navy Department of the United States, and it was further urged that the Illinois representatives in Congress endeavor to secure legislation to this end.

Circular Sewers Versus Egg-Shaped, Catenary and Horseshoe Cross-Sections

Comparisons Made by Means of Curves—Superiority of Different Sections Shown to Be Dependent Upon Quantity of Flow

By R. DeL. FRENCH
Lecturer in Municipal Engineering, McGill University, Montreal

THE CLAIM of egg-shaped sewers for consideration from sanitary engineers rests upon the fact that by their use it is possible to secure comparatively high velocities with small flows, and hence the danger of a sewer's becoming obstructed by deposits is lessened. Just what their superiority in this respect amounts to is stated only generally in the standard texts on sewerage and hydraulics, if, indeed, it is quantitatively stated at all. Professor Ogden, in his "Sewer Design," compares the velocities in egg-shaped and circular sewers for four *depths* of flow. This seems hardly a logical proceeding; really it is not the same *depth* of flow that should be compared, but the same *quantity*. Folwell's "Sewerage" devotes a page to the discussion of this point, but gives only one specific example.

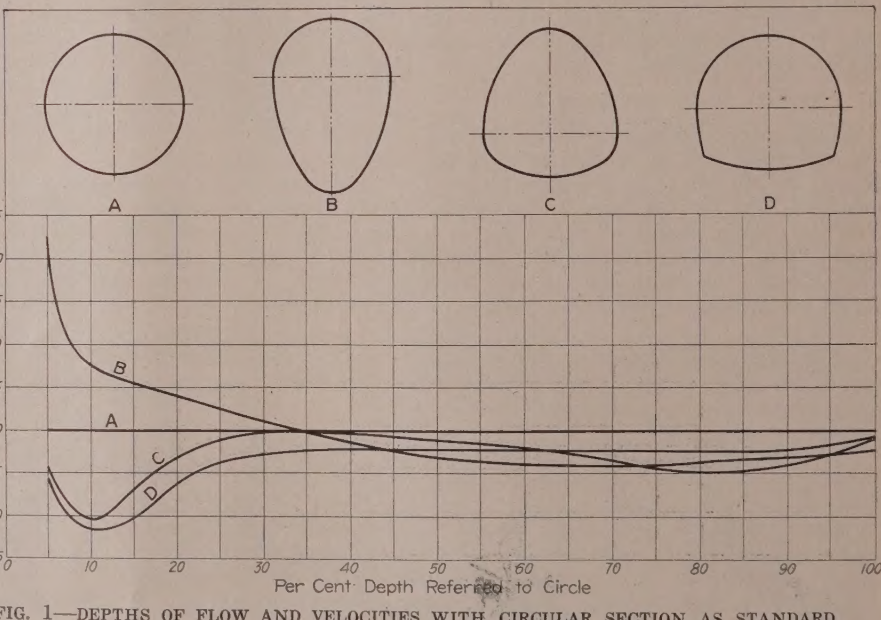


FIG. 1—DEPTHS OF FLOW AND VELOCITIES WITH CIRCULAR SECTION AS STANDARD

All rights to the above drawing are reserved by the author, to whom application should be made for permission to reproduce it.

SECTIONS COMPARED

Eltinge and Beard of Kansas City made a comparison of the velocities of flow in egg-shaped and circular sewers, and gave a diagram to cover the case. Their letter on the subject was published in the Engineering Record of July 26, 1913, page 112. The writer is not aware of the method they employed in the computations for this diagram, but is under the impression that it must have been similar to his own, used in the development of the curves of Fig. 1.

It is often stated that other sewer sections, such as horseshoe, parabolic, semi-elliptical, rectangular, etc., are inferior to the circular, but no definite statement of the amount of their inferiority as regards velocity has ever come to the writer's attention. As there seems to be an utter dearth of data on this subject, the writer has computed and plotted the curves of Fig. 1 for use in his classes.

The four sections shown were chosen as typical and are respectively circular, egg-shaped, the catenary section of the Metropolitan Water and Sewerage Board of Massachusetts, and the horseshoe section adopted as a standard by St. Louis, Mo. As shown in the diagram, they are drawn to scale so as to give equal capacities when laid on the same grade. Consequently it may be roughly judged from the sketches how they will compare in dimensions for any given case.

Method of Computation

A short description of the methods used in computing the quantities from which the graphs of Fig. 1 were plotted will more clearly show their meaning than is possible otherwise. Assume that the circular and egg-shaped sections are to be compared. Data for the curves of Fig. 2 must first be computed and the curves constructed therefrom.

In this case the Kutter formula was used, but any other would serve equally well. These give the relation of the velocity and discharge at any depth of flow to the corresponding quantities when the section is flowing full for the two sections under comparison, and will be recognized at once as the familiar curves of "hydraulic elements."

Since the circular section is the most common form in use, we will call this the standard, and the curves of Fig. 1 are referred to it. Assume a depth of flow in the circular section of, say, 10 per cent of its diameter. From Fig. 2 the discharge and velocity are then 2.2 per cent and 40.8 per cent of their respective values when the section is flowing full. Turning to the egg-shaped section, we find that when 2.2 per cent of the total capacity is flowing, the velocity is 42.0 per cent of the velocity when flowing full.

If the velocity in the two sections were equal when both were flowing full, we should now be in a position to compare the velocities for partial flow just found. The velocity in the egg-shaped section is, however, only about 95.7 per cent of the corresponding velocity in the circular section, both flowing full. Therefore, the partial velocity for the former must be corrected to bring it to a basis of comparison with the latter partial velocity. Thus, the partial velocity in the egg-shaped section, referred to the standard circular section, is 42.0 ÷ 0.957 = 43.8 per cent. The excess of velocity in the egg-shaped section over that in the circular for the same discharge (10 per cent of the total depth of the circular section) is then 43.8 — 40.8 = 3.0, and the percentage excess is 3.0 ÷ 40.8 = 0.075 or 7.5 per cent.

Making similar computations for other depths of flow in the circular section will give points enough so that a smooth curve like those of Fig. 1 may be drawn. The procedure followed in developing the graphs for the other sections is exactly similar to the example just given.

Accuracy of Curves

The accuracy of Fig. 1 depends wholly upon the accuracy of Fig. 2. As it is extremely difficult to read correct values from these latter curves below a proportional depth of about 5 per cent, no attempt has been made to extend the curves of Fig. 1 below this point. Even here it is probable that the curves are slightly in error. However, as all the computations are based on Kutter's formula, which is known to give results which are not entirely correct, it is thought that Fig. 1 represents the case as nearly as the facts warrant.

An inspection of these curves brings out the following points regarding the merits and defects, from a velocity standpoint, of the four sections examined:

1. The egg-shaped section is superior to the circular, up to a point where the quantity flowing is sufficient to fill an equivalent circular section to about 35 per cent of its depth. For larger quantities the circular section is superior, but by only about 4 per cent.

2. The catenary section is superior to the horseshoe, except for flows which will nearly fill either, and then it is only about 2.5 per cent inferior. For flows up to those which will fill an equivalent circular section to about 25 per cent of its depth, both these sections are quite inferior to the latter, the deficiency in velocity ranging as high as 10 per cent. For flows which will fill a circle half full or more they are practically as good as the circular.

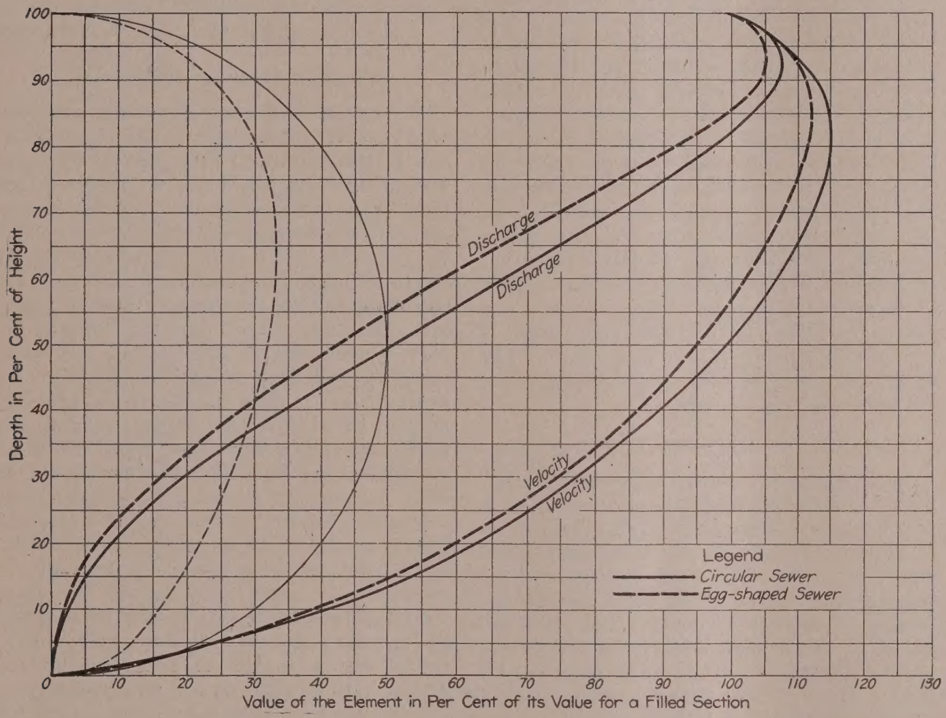


FIG. 2—HYDRAULIC ELEMENTS OF CIRCULAR AND EGG-SHAPED SECTIONS COMPARED

Old Steel of Razed Building Examined for Rust

Only Slight Deterioration Found in Painted Members of Champlain Building, Chicago, Built in 1894

FROM a recent examination of the rusting of the 20-year-old steel members of the 15-story Champlain Building in Chicago, which has been razed to make way for a new structure, Holabird & Roche, the architects who prepared the original plans, conclude that the exclusion of air and moisture is essential for the preservation of the steel and also of the paint. The appearance of the rust suggests that it may have been formed soon after the building was constructed in 1894 and that it has not been progressive. Even if the worst case of rusting had been progressive and should continue at the same rate, it would be more than a century before failure of the member would result, according to the architects. They conclude that the present practice of encasing all structural steel in concrete or plastering it with Portland cement mortar, of separating the pipe shafts from the steel and of using greater care in covering terra cotta anchors, safeguards the framework of the structure for a much longer period than the probable economic life of such buildings.

The lot occupied by the Champlain Building is approximately 66 x 105 ft. The building, which cost $500,000, was 15 stories above grade and one shallow basement story below grade. It consisted of a structural steel framework with joists spaced 5 ft. apart, flat-tile arches of porous terra cotta, porous terra cotta fireproofing, shallow spread footings on a blue clay foundation, locally called floating foundations, and brick and terra cotta curtain walls.

Condition of the Paint

The steel was painted with a proprietary brand of iron-oxide paint, in accordance with the following specifications: "The contractor will be required to paint all ironwork and steelwork one coat of the best quality of mineral paint before putting up. After it is set, carefully go over all work, clean and remove all rust and dust and paint another coat of the same kind of paint."

The condition of the paint varies from complete disappearance to "good as new." So far as protection to the general structure is concerned the paint has deteriorated beyond all usefulness. In places there is no trace of it. Over most of the steel the paint still shows, but is broken up by rusted areas, in a few places it still has its color and luster over considerable areas. Even where small blisters showed in the paint, the steel underneath was bright and free from rust.

Rusting of Steel

There was no pitting of the steel observed, the rust occurring in flakes or layers. Some pieces having areas from 50 to 100 sq. in. were removed from webs of I-beams. By weighing some specimens of rust scales taken from the inner sides of the webs of beam box girders not filled with fireproofing and reducing to the equivalent metallic iron, the loss due to corrosion is computed to be .007 to .009 in.

This is very much greater than the average loss, as these specimens represented the worst condition except one case. One column in the first story showed rust amounting to perhaps four or five times the amount stated above. This bad rusting was along a pipe shaft where the steel was doubtless subjected to moisture or circulation of air.

Footings, Pipes and Anchors

The footings were built of steel I-beams unpainted, embedded in Portland cement concrete. When removed they showed no corrosion. The pipes in the building were generally in fair condition. There is no record of any of them having been replaced since the building was constructed. However, one pipe, presumably a soil pipe, was so decayed that it could be broken as if made of earthenware.

It was specified that the terra cotta be attached to the steel frame "with substantial wrought-iron or copper anchors, and thoroughly embedded in cement mortar." Wrought iron or steel was used. The anchors were generally in good condition, but some pieces were rusted so much that they were broken in wrecking. It is probable that these pieces were not well bedded in cement mortar at the points where the rusting occurred.

Tropical Road Maintenance Complicated by Floods

Philippine Engineers, in Annual Conference, Discuss Means of Preventing Erosion of Surfacing During Periods of Inundation

THE conference of district engineers in the employ of the Bureau of Public Works of the Philippine Islands, held at Baguio, Feb. 10 to 16, was devoted principally to the design, construction and maintenance of roads in tropical countries. Oiled roads, asphaltic macadam, or concrete surfacing and a dike on the downstream side of water-bound macadam roads were suggested as means of preventing damage to roads subject to periodic flooding. The painting of structural steel was recognized as particularly important in the Philippines and several recommendations were made as to means of obtaining the best results. One speaker recommended fords instead of bridges, in places where the depth of water would not be sufficient to interfere seriously with traffic, as one means of obtaining the maximum mileage of road from the moneys appropriated for such purposes.

Overflow Sections

Overflow sections, as defined by one of the speakers, is a name applied to a section of road subjected to periodical inundation, generally two or three times a year. This subject was dealt with by a committee of five. Three general cases were cited: Meandering rivers, where the channel requires a bridge and is one-half to one-fourth the width of the overflow section; sections where the ditches and culverts are inadequate, and flat country where the road is covered with water, at times, several feet deep. In the latter case the water sometimes flows across the land in one direction while rising and in another when receding.

Three different methods of treating these conditions were named. The first method consisted in building an embankment high enough to prevent the water from rising above it. This idea was discarded as being prohibitive in cost and on account of the certainty that the embankment would act as a dam and would have its stability endangered by percolation beneath it. The second method proposed a viaduct, which also would be impractical in the Philippines on account of the excessive cost. The third method involved treating the surfacing so that it would be able to withstand the scouring action of the flowing water. Methods proposed for accomplishing this were by oil, asphaltic macadam, concrete surfacing, and, in the case of water-bound macadam surfacing, by building a dike on the downstream shoulder. Asphaltic overflow sections have proved fairly successful in the Philippines in locations where the flood water does not remain on the road longer than a day at a time and where the subgrade is well drained. But where the road is submerged for long periods and, especially where it is subjected to wheel traffic while saturated, the asphaltic compound is said to deteriorate through emulsification and the surfacing rapidly goes to pieces. Concrete pavement is also subject to certain objections, of which the high cost is most serious. The dike method bases its claim to effectiveness upon the proposition that water-bound macadam is not injured by being submerged provided the water actually in contact with the metaling is not in motion. Hence the downstream shoulder is raised to a certain distance above the crown and the downstream side slope is sodded or riprapped against scour. The crown, for best results, should be very flat or even entirely absent.

Economics of Highway Construction

H. F. Cameron, senior supervising engineer of Mindanao and Sulu, presented a paper on the economics of highway construction. Among the points he emphasized were: Location by careful surveys and investigations; an adequate right-of-way obtained in advance of construction; the acquisition of all quarry sites and gravel deposits, whether on roads to be built in the near future or not; large jobs instead of small and widely scattered jobs; care in considering the purchase of machinery for work in sections where labor is cheap. He also suggested, as a means of obtaining the greatest mileage from the funds appropriated for road building purposes, that where the depth of the water is not sufficient to interfere with the class of traffic for which the road is designed, a rock ford or a concreted or asphalt overflow section should be substituted for a bridge.

Oil Treatment of Surfacing Roads

Oil treatment was characterized by one speaker as being cheap and capable of giving an excellent dustless surface in dry weather, but as having the disadvantage of forming an oily mud during the rainy season, very destructive to rubber tires. One application per year was considered as sufficient under ordinary traffic.

It was questioned whether bituminous construction is adapted to present conditions in the Philippines. The limitations of any asphaltic compound in the presence of excessive moisture were fully recognized but, in view of the increasing heavy demand being made upon the improved roads by motor trucks, the desirability of further experiments with bituminous macadam was generally conceded.

Recommendations as to sizes of maintenance material varied considerably. For filling shallow ruts, correcting slight unevenness in the road surface and similar repairs, ½-in. and ¾-in. stone were generally preferred for both gravel and macadam roads.

Driving Concrete Piles

The experiences cited by different speakers revealed the fact that concrete piles can be driven with almost any kind of a driving outfit that can be put together. In a case in one province the driver and boiler were placed on the bank, separate from the pile driver, thus permitting the moving of the driver with less work, cost and time than if the weight of the engine and boiler had to be moved. The power plant remained at one location during the construction of each bridge, the cables being let through snatch blocks so as to obtain a direct pull. For driving concrete piles in clay it was recommended that a hole be made by driving in a 12 x 12-in. timber and then withdrawing it.

Painting of Steel Structures

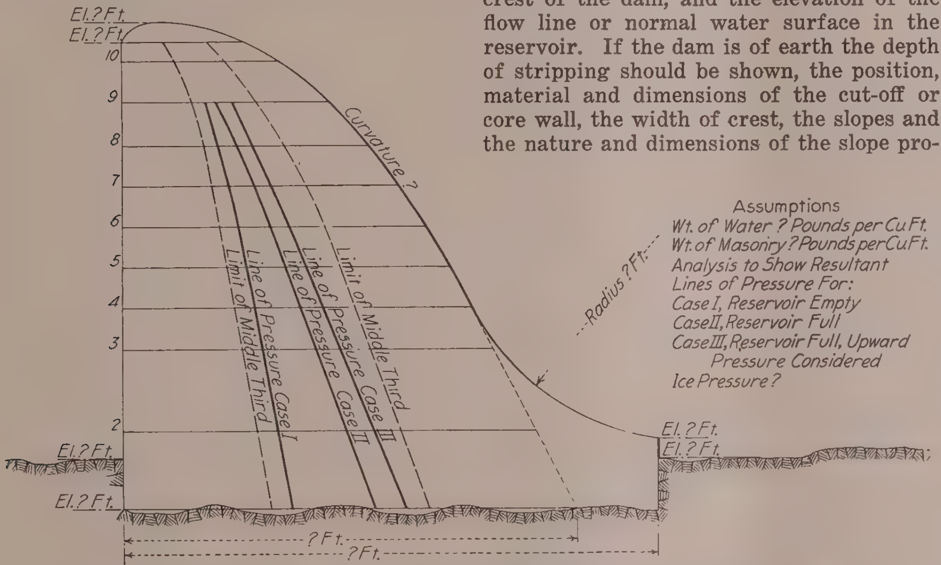
Preservation of steel structures was conceded to be a matter of vital importance, and it was admitted that past experiences with paint had not been as successful as could have been desired. Several recommendations were agreed upon, among them the following: The use of pitted steel should be prohibited by specifications; standard specifications should provide that all plates and shapes be cleaned by sand blasting before assembling in the shops; for shop painting red lead should be used, as at present; all bridges painted with graphite primer should be thoroughly cleaned and repainted in accordance with standard specifications; no field painting should be done except after the most careful and thorough cleaning of the steel surface, and then only after 4 hr. of sunshine on a bright, warm day, so as to insure a dry surface on which to paint; the use of tar paint should be discontinued, except as required for special purposes, in which case special specifications should be prepared by the division of design or in duly authorized tests; boiled oil should be used for bridge painting instead of raw oil, and one or more portable sand blast outfits for use in the field should be supplied. The Kansas City method of coating steel with cement grout put on with a cement gun and held by wire mesh reinforcement came in for a slight discussion, and it was suggested that the method might prove advantageous for steel bridges over salt water.

The German Museum of Munich, which has done such notable work in bringing together an historical collection showing the development of engineering in all branches, has, in conjunction with the Bavarian government, fitted out a Red Cross train for use of the Bavarian troops. The museum has taken full advantage of its distinguished technical membership to insure that the train lacks none of the improvements which medical and engineering science render available. The operating and disinfecting cars are exceptionally well equipped. The train consists of twenty-nine cars, as follows: Fourteen cars for enlisted men, each containing fourteen beds; one car for officers, with seven beds; two cars for doctors and nurses, and two for other hospital attendants; three cars for baggage and storage and one each for operating, disinfecting, electric lighting equipment, officer in charge, cooking, provisions and linen. The car for linen is fitted with a small laundry. The crew for handling the train, including doctors and nurses, is forty-six.

Pennsylvania Commission Issues Rules Regarding Dams

Give Complete Instructions for Prospective Dam Builders to Aid Water Supply Board to Study Propositions

AN ACT passed by the Pennsylvania Legislature in June, 1913, makes it unlawful to construct any dam or other water obstruction, or to make any change in or addition to an existing dam in that State without the consent or permit of the Water Supply Commission upon written application, to be accompanied by complete maps, plans, profiles and specifications and such data as the commission may require. Rules and instructions have just been issued by the commission to aid its engineering department and for the guidance of those interested. The following extract of the requirements for submitting plans is taken from these instructions, and is accompanied by a typical drawing of the cross-section of a masonry dam. Five other sample drawings are included in the pamphlet issued by the commission.



THIS IS THE KIND OF DRAWING WHICH PENNSYLVANIA DAM BUILDERS ARE REQUIRED TO SUBMIT FOR APPROVAL TO THE WATER SUPPLY COMMISSION

DETAIL OF PLANS SUBMITTED

The plans and specifications to be submitted with each application should illustrate and describe in detail the proposed structure and the methods to be employed in its construction, and should include the following:

(a) A location plan or map, showing the stream on which the dam is to be built, the tributary drainage area and the principal topographical features of the surrounding country, such as streams, roads, railroads, cities, towns, etc. The scale of such a plan should be about 1 in. to the mile, unless this scale would make a plan of inconvenient or unwieldy size, in which case a different scale may be used.

(*b*) A general plan of the dam and reservoir to show accurately the position of all essential details, such as spillway or wasteway, its point of discharge into the stream, pipes through the dam, inlets, outlets, screen chamber, gate or valve house, headrace, canal, mill or power plant, tailrace, etc. The area of the water surface of the pond or reservoir should be shown in acres, and the capacity indicated in cubic feet or gallons.

(c) A longitudinal section of the dam or cross-section of the valley at the site of the dam, showing the elevation of the crest of the dam, the elevation of the flow line of the reservoir, the original surface of the ground, the nature and depth of the underlying strata, and the probable depth of the excavation for the foundation or cut-off. Subsurface investigations should be made at the site of the dam, by means of test pits or borings.

(d) Typical cross-sections, which should be drawn to a scale of not less than 1 in. to 10 ft., and include a maximum section of the dam. They should show the original surface of the ground, and subsurface conditions as disclosed by test pits or borings, the probable depth of excavation for foundations or cut-offs, the elevation of the crest of the dam, and the elevation of the flow line or normal water surface in the reservoir. If the dam is of earth the depth of stripping should be shown, the position, material and dimensions of the cut-off or core wall, the width of crest, the slopes and the nature and dimensions of the slope protection, the position and dimensions of outlet pipes or culverts and cut-offs to prevent seepage along such structures, the disposition of different qualities of earth, if of varying quality, and the methods and manner of construction. If of masonry, the cross-sections should show all dimensions and should indicate the position and kinds of masonry to be included in the structure.

(e) Detailed plans of the spillway, wasteway or overflow, showing the depth of the opening and its length, together with the width and shape of the crest, grade and shape of the approach and discharge channels, if any, methods of protecting the toe of the dam or end of the discharge channel from erosion. They should also give the dimensions of all walls, floors, paving, etc. Inasmuch as a large percentage of dam failures is due to lack of adequate spillway capacity, special attention should be paid to this feature of the design.

(f) Detailed plans of the outlets or controlling works, showing the location and dimensions of all valves or sluice gates, intakes, screen chambers, racks, outlet towers and gatehouses and appurtenances.

(g) Diagrams of forces for masonry dams, showing the results of the graphical or mathematical analyses, together with the weights and different conditions assumed, and the maximum pressures under these conditions. (See drawing herewith.)

(h) For reinforced-concrete dams, in addition to the above, detailed plans should be submitted showing the sizes and spacing of all reinforcement, expansion joints, dimensions, etc.

SPECIFICATIONS

The specifications should describe carefully and in detail the preparation of the site of the dam, the materials to be employed in its construction, their arrangement in the structure, the methods to be used and the results to be obtained. If stone or concrete masonry is to be used the different kinds or classes should be carefully described, and the materials and proportions accurately specified.

If an earth embankment forms an essential part of the dam the quality or qualities of material should be specified, and the manner of depositing in the embankment; and if in layers, the thickness of the layers, weight and kind of roller to be used, manner of sprinkling, size of stone to be allowed to remain in the material, etc., should be specified. The slopes to be used on the upstream and downstream sides should be indicated, as well as the manner of protecting each slope from erosion.

REPAIRS

If it is proposed to make changes in or alterations to an existing dam, or to use flashboards, or to make repairs, other than ordinary maintenance work, an application for a permit should be filed with the commission. The plans accompanying applications in such cases should show in detail the existing conditions as well as the proposed changes.

CONDITIONS ATTACHED TO PERMITS

When an application for a permit to construct or repair a dam is approved by the commission the following general conditions are made a part of the permit, together with such other conditions as are considered necessary in the particular case under consideration:

1. That the commission shall be notified in advance of the proposed time of commencement of work upon the dam and of the time of the preparation of the foundation for the same; that work shall not be started upon the foundation subsequent to this notice until the said foundation has been approved by the engineer of the commission or his representative.
2. That the dam shall be built under the direction of a competent engineer, and that he or his representative shall be on the ground daily (or frequently, depending upon the importance of the project) during construction to interpret and enforce the plans and specifications.
3. That a detailed report upon the status of the construction shall be furnished to the engineer of the commission on the fifteenth and last days of each month.
4. That the construction of the dam shall at all times be subject to inspection by representatives of the commission, and that no changes in the plans as approved shall be made except with the written consent of the commission or its engineer. The commission reserves the right to require such changes as may be deemed necessary during the progress of construction.

HIGHWAYS to be constructed this year in King County, Washington, and exclusive of work within city limits, will total in cost about $1,000,000. This includes 1.4 miles of brick pavement, 6.5 miles of one-course concrete pavement and about 100 miles of graded and graveled highway.

Railroad's Maintenance Expenses Allocated Between Freight and Passenger Service

Percentages Used, and Reasons Therefor, in Rate Case Studies Made by William J. Wilgus for the Ulster & Delaware Railroad

THE gradual reduction in its net income and the impossibility, on the present basis, of earning an adequate return on the investment caused the Ulster & Delaware Railroad to make a thorough investigation of its revenue and expenses with the view of praying for such relief from the Public Service Commission of the Second District, New York, as the facts disclosed would warrant. For this investigation the railroad company retained William J. Wilgus, consulting engineer, of New York. As a result of his findings, the company petitioned the Public Service Commission for permission to increase the mileage book rate from two cents to three cents per mile. A discussion of the decision of the Public Service Commission, which was adverse to the railroad company's request, will be found in the Engineering Record of Aug. 7, 1915, page 154.

In making his studies Mr. Wilgus gave much time to the allocation of expenses between passenger and freight service, a matter, as is well known among railroad men, beset in some classes of expenses with very great difficulty. He has studied at length, for example, the matter of allocating the maintenance-of-way and structure expenses between the two classes of service. The portion of the report printed below relates chiefly to this feature, but since the allocation of these particular expenses influences other allocations, the entire distribution is followed through to the final percentages, and then to the final study, which consisted in splitting what are ordinarily considered as passenger revenues and expenses between actual passenger, express and mail service.

VALUE OF PROPERTY

Antecedent to the study of revenues and expenses a valuation of the property was made. While the book cost is $5,961,953, the evaluation, on a reproduction-less-depreciation basis, was found to be $8,230,512. With working capital added, the appraised investment, with depreciation deducted, is $8,719,051. Mr. Wilgus does not favor the deduction of the depreciation, amounting to $682,199, but since this matter is much in dispute and in order to remove it from the controversy he has deducted it. Mr. Wilgus also found that there should be added to expenses for the year 1914 $32,086 in order that they may fairly reflect the true and proper cost for that year, or in other words, that sum should have been credited to operating reserves on account of deferred maintenance.

The portions of the report printed below follow the text very closely, omitting only the detailed exhibits and, from some of the tables reproduced, the amounts in dollars and cents, as from the standpoint of general interest the ratios are the more important. The portion of the report relating to allocation of expenses is as follows:

USAGE PRINCIPLE APPLIED

It is claimed by many that the division of common or joint expenses between freight service and passenger service is impossible of reasonably accurate accomplishment. For instance, it is said that a large share of the costs of tie renewals and track labor is in part governed by the action of the elements, and to that extent may not be divided on any basis of usage; also that the movement of freight and passenger trains is so interdependent that any favoritism to one class throws an extra burden of expense on the other, without any possibility of making a fair distribution.

Beyond question a precise allocation of common or joint expenses is not practicable, but on any given road it would seem feasible to make a division that will be so equitable that the margin of error may be considered negligible or at least unimportant. In other words, a carefully chosen method, based on usage, should give approximately correct even if not precise results. As a rule the adoption of a defensible alternate usage method of dividing a common expense will not produce a substantially different result.

DIVISION OF PROPERTY INVESTMENT

When it comes to a division of the property investment there has been room for even wider ranges of opinion. Some have taken the position that the revenue or return should be the measure, but the Minnesota Rate Case decision very properly has disposed of this illogical method in the following language:

"If the property is to be divided according to the value of the use, it is plain that the gross earnings method is not an accurate measure of that value."

"The value of the use, as measured by return, cannot be made the criterion when the return itself is in question. . . . When the rates are in controversy it would seem to be necessary to find a basis for a division of the total value of the property independently of revenue, and this must be found in the use that is made of the property."

The usage methods employed in the report are in harmony with the general principle thus approved by the Supreme Court, and they are believed logically to accord with railroad conditions and practice.

ALLOCATION OF REVENUES

Operating revenues, constituting 97 per cent of the gross revenues reported in the income account of the company, are assignable direct to freight and passenger services respectively. The small remainder, consisting of "other income" and not from auxiliary operations, has been allocated in the same proportion as the operating revenue, viz., 63.1 per cent to freight and 36.9 per cent to passenger service.

Profit and loss adjustments, affecting as they do the property as a whole, have been apportioned at the ratios hereinafter found to apply in the case of the investment in road and equipment, viz., 59.8 per cent to freight and 40.2 per cent to passenger service.

Allocation of Operating Expenses

MAINTENANCE OF WAY AND STRUCTURES

Track and bridge items have been apportioned on the basis of the gross ton-mileage that passes over them, in which is included the total weights of locomotives, cars and contents multiplied by the miles moved.

As regards the comparative effect per ton of weight of passenger and freight trains, it is the opinion of Mr. Wilgus that, generally speaking, there is no appreciable difference, if in considering the higher speeds in passenger service equal attention is paid to destructive agencies peculiar to the freight service, such as drippings and droppings from coal and refrigerator cars, imperfections of equipment and heavier wheel concentrations, twisting action of the locomotives at slow speeds and the interference of slow trains with track labor, the fouling and destructive action of the products of combustion of inferior grades of coal often used in freight services, and more frequent stoppages and reversals of movements.

EFFECTS OF FREIGHT TRAFFIC

Corrosive drippings are detrimental to floorbeams and stringers, and solid floors of bridges; to track fastenings such as spikes, tie-plates, bolts and splices; and to rails, frogs and switches. Droppings from freight trains such as lumps of coal, rubbish, loose doors and other broken parts, increase danger and add to the cost of policing.

Side bearings on freight cars are so stiff as to provide much less freedom of adjustment to varying track conditions than on passenger cars. This has been strikingly shown on tracks used exclusively for freight traffic, where trucks in passing from curve to tangent retain their slewed position and grind the outer rail for considerable distances. Springs under freight cars are less delicately adjusted than on passenger cars, with correspondingly greater shock to track and structures, especially in the case of eight-wheel coal cars having 18,750 lb. per wheel as contrasted with twelve-wheel passenger coaches, weighing but 12,500 lb. per wheel. Superworn tires, flat spots on wheels, dragging brake-beams and draft rigging, and similar imperfections peculiar to freight equipment, cause additional wear and tear.

Slowly moving freight locomotives when exerting their maximum tractive force, cause a twisting action from side to side that tends to work track out of line as much or more than higher speed passenger trains; and it is well known that a long slow-speed freight train causes more interference with track labor, from suspension of operation of section men while the train is passing, than in the case of passenger trains that move quickly and therefore are out of the way more promptly.

Freight locomotives consume more coal and frequently use a poorer grade of fuel, and the resulting larger volume of cinders, gases, and smoke fouls the ballast, corrodes metallic structures, and injures paint on buildings, bridges, and signals to a greater extent than with passenger power.

Freight locomotives under load stop and start more frequently, causing slipping of drivers that blisters and wears the rail. Local freights do more or less switching on main tracks and at stations, with accompanying wear and tear on track and structures.

JUDGMENT MUST GUIDE DECISION

It therefore seems clear that relative speeds of passenger and freight trains are so variable, and the instances in which the latter are more destructive to track and structures so numerous, that any attempt arbitrarily to fix the percentage that one exceeds the other would lead to questionable results. Judgment, which in any event must guide a decision, would seem to lead to the conclusion that, taking all these facts into consideration, the added cost of maintenance chargeable to passenger service by reason of higher speeds is practically offset by many features incident to the slower speed traffic.

As to the comparative effect of locomotives and of the load they haul, it is possibly true that the former cause somewhat more damage per ton than the latter, but not to the extent that might be imagined. For instance, taking two loaded coal cars weighing 150 tons, their smaller diameter wheels, less perfect construction and maintenance, and drippings and droppings may be said to go far toward equaling the twisting and corrosive effects of a locomotive of the same weight; and in passenger service the smaller wheels and tail-end side swing may be considered as going far toward equaling the destructive action of the locomotive.

Summarizing, in the absence of precise data, and taking into account the complexity of the problem, it seems fair to say that under *average conditions* a gross-weight ton of passenger train creates the same destructive effect on track and bridges as a gross-weight ton of freight train; and that an attempt to assign constructive tonnage to portions of the rolling load as the measure of their assumed excess wear and tear on track and structures, will result either in complications and contradictions, or in so many variations in the formula as to make the exceptions prove to be the rule.

OTHER MAINTENANCE OF WAY ITEMS

Such items as crossings, fences, signals, removal of snow and ice, buildings, docks and wharves, have been divided on the basis of train-mileage, as that measure of usage appears to most nearly fit the case.

The maintenance of certain tracks and structures has been assigned direct to the service in which they are exclusively engaged.

All items unapportionable on a usage basis, such as superintendence, stationery and printing, etc., have been allocated in the same proportion as the sums of the other items.

MAINTENANCE OF EQUIPMENT AND TRAFFIC EXPENSES

Locomotive costs have been divided on the basis of locomotive mileage, car costs have been assigned direct, and all others have been apportioned from the sum of the allocations thus obtained. Locomotive costs have been divided on the basis of locomotive mileage, because the same engines are used interchangeably in freight and passenger service—in other words, the road has only one class of locomotives.

The larger part of traffic expenses are assignable direct and the small balance has been divided on the ratios obtained therefrom.

TRANSPORTATION AND GENERAL EXPENSES

Items affected by train movements, such as dispatching trains, signals and interlocking, crossing flagmen and gatemen, train supplies and expenses, and station costs have been apportioned on the basis of train-mileage, except those portions that are assignable direct.

TABLE 1—PERCENTAGES OF EXPENSES CHARGEABLE TO FREIGHT AND TO PASSENGER SERVICE

Account	Freight Service, Per Cent	Passenger Service, Per Cent
Maintenance of way and structures	61.2	38.8
Maintenance of equipment	47.2	52.8
Traffic expenses	28.5	71.5
Transportation expenses	58.8	41.2
General expenses	56.2	43.8
Total, operating expense ratios	56.1	43.9
It is interesting to note in this connection that the operating revenue ratios are	63.1	36.9

Yard expenses have been allocated on the basis of yard locomotive mileage, while road enginehouse costs, and lubricants and other supplies for road locomotives, have been apportioned on the basis of road locomotive-mileage.

For allocating the costs of enginemen, fuel, water and trainmen in road service, ratios were ascertained from actual observations and tests on the ground, as the company's records do not separate these items between the two classes of service.

Of the remaining items a portion could be assigned direct, and the balance, unapportionable on a usage basis, including superintendence, stationery and printing, etc., has been allocated in the same proportion as the sums of the other items.

A small part of the general expense was found to be assignable direct, and the remainder has been divided in the same proportion as the totals of all of the other operating expenses.

Following the procedure as thus outlined the resultant ratios, shown in detail in Table 2, are those given in Table 1.

ALLOCATION OF OTHER ITEMS

Hire of equipment is assignable direct, but taxes have required division and for this purpose the use of the ratios found to

TABLE 2—PERCENTAGES SHOWING ALLOCATION, IN DETAIL, BETWEEN PASSENGER AND FREIGHT SERVICES, FOR YEAR ENDED JUNE 30, 1914.

Items	Basis of Allocation	Passenger, Per cent	Freight, Per cent
I.—Maintenance of Way and Structures:			
(1) Ballast; ties; rails; other track material; roadway and track; bridges, trestles and culverts; and roadway tools and supplies—in joint service	Gross ton mileage	34.9	65.1
(2) Above-mentioned items (1) exclusively in passenger service	Actual	100.0	....
(3) Above-mentioned items (1) exclusively in freight service	Actual	.....	100.0
(4) Removal of snow, sand and ice; over and undergrade crossings; grade crossings, fences, cattle-guards and signs; snow and sand fences and snow sheds; signals and interlocking plants; buildings, fixtures and grounds; and docks and wharves—in joint service	Rev. train mileage	55.9	44.1
(5) Above-mentioned items (4) exclusively in passenger service	Actual	100.0	....
(6) Above-mentioned items (4) exclusively in freight service	Actual	.....	100.0
		38.8	61.2
(7) Supt.; injuries to persons; stationery and printing; other expenses; and maintenance joint facilities	Av. of above allocations (I)	38.8	61.2
Total, maintenance of way and structures		38.8	61.2
II.—Maintenance of Equipment:			
(1) Locomotives	Rev. loco. mileage	47.2	52.8
(2) Passenger-train cars	Actual	100.0	....
(3) Freight-train cars	Actual	.....	100.0
		52.8	47.2
(4) Supt.; work equipment; injuries to persons; shop machinery and tools; stationery and printing and other expenses	Av. of above allocations (II)	52.8	47.2
Total, maintenance of equipment		52.8	47.2
III.—Traffic Expenses:			
(1) Assignable direct	Actual	71.5	28.5
(2) Joint	Same as actual	71.5	28.5
Total, traffic expenses		71.5	28.5
IV.—Transportation Expenses:			
(1) Despatching trains; station employees; station supplies and expenses; interlockers and block and other signals; crossing flagmen and gatemen—in joint service	Rev. train mileage	55.9	44.1
(2) Above-mentioned items (1) exclusively in passenger service	Actual	100.0	....
(3) Above-mentioned items (1) exclusively in freight service	Actual	.....	100.0
(4) Weighing and car service associations; coal and ore docks; and loss and damage	Actual	0	0
(5) Yard expenses	Sw. loco. mileage	17.5	82.5
(6) Road enginemen	Actual, based on tests	39.4	60.6
(7) Fuel for road locomotives	Actual, based on tests	41.0	59.0
(8) Enginehouse expenses—road	Rev. road loc. mile	49.3	50.7
(9) Water for road locomotives	Actual, based on tests	41.0	59.0
(10) Lubricants for road locomotives	Road loco. mileage	49.4	50.6
(11) Other supplies for road locomotives	Road loco. mileage	49.4	50.6
(12) Road trainmen	Actual, based on tests	39.4	60.6
(13) Train supplies and expenses	Rev. train mileage	55.9	44.1
(14) Clearing wrecks (part)	Actual	.....	....
(15) Damage to property (part)	Actual	.....	....
(16) Damage to stock on right-of-way (part)	Actual	.....	....
(17) Stationery and printing (part)	Actual	.....	....
(18) Other expenses (part)	Actual	.....	....
(19) Injury to persons (part)	Actual	.....	....
(20) Operating joint yards and terminals	Actual	.....	....
		41.2	58.8
(21) Supt.; clearing wrecks; damage to property; damage to stock on right-of-way injuries to persons; stationery and printing; and other expenses, exclusive of above items, 14 to 19, inclusive	Av. of above allocations (IV)	41.2	58.8
Total, Transportation Expenses		41.2	58.8
Grand total, exclusive of general expenses		43.8	56.2
V.—General Expenses:			
(1) Assignable direct	Actual	.....	....
(2) Joint	Av. of above allocations (I-IV)	43.8	56.2
Total, general expenses		.....	....
Grand total, operating expenses as reported		43.9	56.1

obtain in the hereinafter described apportionment of the investment in road and equipment seemed equitable, viz., 59.8 per cent to freight and 40.2 per cent to passenger service.

Small portions of the investment in road have been apportionable direct to each service. The remainder devoted to joint service has been divided on the same ratios of usage that were found in the case of maintenance of way and structures: 61.2 per cent freight and 38.8 per cent passenger.

TABLE 3—ALLOCATION OF INVESTMENT TO FREIGHT AND PASSENGER SERVICE

	Freight Service, Per Cent	Passenger Service, Per Cent
Road	61.9	38.1
Equipment	43.4	56.6
Total, road and equipment	59.8	40.2

Equipment has been apportioned by assigning cars direct to the services in which they are used exclusively, and by allocating the locomotive on a switching and road locomotive mileage basis respectively. Work equipment and overhead charges have been apportioned on the ratios obtained from the totals of the above described allocations.

TABLE 4—ALLOCATION OF COST OF ROAD, EQUIPMENT AND WORKING CAPITAL TO PASSENGER AND FREIGHT SERVICES

Item	Service	Basis of Allocation	Ratio Percentage Pass.	Ratio Percentage Frt.
Equipment	Joint	(See text)	56.6	43.4
Road	Passenger	(See text)	100.0	....
	Freight	(See text)	....	100.0
	Joint	Av. Ratio of joint main.-of-way and struct. exps.	38.8	61.2
Total, road			38.1	61.9
Total, road and equipment			40.2	59.8
Working capital (June 30, 1914)			40.2	59.8
Grand total			40.2	59.8

The resulting ratios, shown in detail in Table 4, are summarized in Table 3.

Working capital has been allocated by using the last mentioned ratios of 59.8 per cent and 40.2 per cent.

ALLOCATION OF RESULTS, 1914

Applying these various ratios [this is shown in great detail in exhibits in the report], the results are those given in Table 5.

It will be seen that passenger service returns a much smaller rate on the property investment than freight, the percentage, after making due allowance for the shortage of reserves, being but 1.63 per cent on book cost or 1.12 per cent on appraised cost, in contrast with 4.63 per cent or 3.15 per cent, respectively, on the portion of property assignable to freight service.

TABLE 5—APPLICATION OF PERCENTAGES TO REVENUE AND EXPENSE ACCOUNTS FOR 1914

As Reported by Company: (Insufficient amounts included in expenses for deferred maintenance, etc.)

	Freight Service	Passenger Service
Gross income	$706,242	$413,201
Outgo	565,129	390,694
Net per income account	$141,113	$22,507
Add profit and loss adjustments	43,684	29,367
Total return as reported	$184,797	$51,874
Investment—book cost	$3,577,077	$2,384,876
Rate of return, per cent	5.17	2.18
Investment—appraised cost	$5,251,696	$3,467,355
Rate of return, per cent	3.52	1.50
Operating ratios, per cent	69.1	92.2

As Revised: (Provision for deferred maintenance, etc., increased.)

	Freight Service	Passenger Service
Return as reported	$184,797	$51,874
Less shortage in reserves for deferred maintenance, etc.	19,201	12,885
Total return as revised	$165,596	$38,989
Rate of return:		
On book cost, per cent	4.63	1.63
On appraised cost, per cent	3.15	1.12
Operating ratios, per cent	71.9	95.4

TABLE 6—ALLOCATION BETWEEN PASSENGER, MAIL AND EXPRESS BUSINESS

Revised results, including suitable provision for reserves:	Passengers	Mail	Express
Gross income	$392,400	$16,855	$33,313
Outgo	326,495	24,215	52,869
Net income	$65,905	*$7,360*	*$19,556*
Investment — book cost	$1,929,365	$143,092	$312,419
Rate of return, per cent	3.42	0	0
Investment—appraised cost	$2,805,090	$208,041	$454,224
Rate of return, per cent	2.35	0	0
Operating ratios, per cent	87.1	150.3	166

This difference is further emphasized by comparing the operating ratios. For each dollar earned in the passenger service 95.4 cents are expended in operating expenses, leaving but 4.6 cents for taxes, car hire and return to the investor; while in the freight service for each dollar earned 71.9 cents are disbursed for operating expenses, leaving 28.1 cents for the other obligations.

It is plain that the returns for both classes of service are inadequate, and that any relief should first be sought through an increase of rates in the passenger service which is not bearing its fair share of the load.

RETURNS ON PASSENGER, MAIL AND EXPRESS BUSINESS

As there are three sources of revenue in the passenger service, viz., passengers, mail and express, an inquiry is necessary into the results from each.

The simplest and most easily applied usage method of apportioning joint revenues, outgo and facilities in connection with the three classes of traffic handled on passenger trains, appears to be space-miles, or, inasmuch as all passenger train cars are of equal width, car-foot miles. This method gives proper credit to the relative car-floor space enjoyed by each class of passenger train transportation and ignores relative weights of contents which are such a small proportion of the total gross train weights that they have a negligible effect on the cost of operation.

It will be of interest to note that the United States Senate Committee on Railway Mail Pay has endorsed car-foot-mileage as a proper measure of usage in place of the weight basis.

The ratios ascertained from estimates of comparative floor space areas, furnished by the officials of the company, are as follows:

	Ratio percentage Passengers	Ratio percentage Mail	Ratio percentage Express
Operating revenue	88.7	3.8	7.5
Car-foot-mileage	80.9	6.0	13.1

It will be seen that mail and express enjoy a much larger share of the service and facilities than they yield in revenue.

APPLICATION TO RESULTS FOR 1914

The car-foot-mileage ratios applied in the revenues and expenses for the year ended June 30, 1914, give the results shown in Table 6.

SUMMARY AS TO PASSENGER, MAIL AND EXPRESS BUSINESS

That the oft repeated dissatisfaction with present mail and express compensation on railroads generally throughout the United States applies with equal force to the situation on the Ulster & Delaware Railroad is apparent from this showing. These two classes of transportation are operated at a distinct loss, but there is no remedy obtainable until the Government takes suitable action through Congress and the Interstate Commerce Commission.

TABLE 7—PASSENGER FARES PER MILE, 1914

	Cents	
Gross revenue:		
Operating revenue—Fares	2.49	
Miscellaneous	0.01	
	2.50	
Other revenues	0.29	
		2.79
Outgo:		
Operating expenses, including shortage in reserves	2.18	
Other outgo	0.14	
		2.32
Balance for return on investment, additions and betterments, etc.		0.47

Therefore, partial relief may be had through passenger fares only, the averages, of which per mile in 1914 were as those shown in Table 7.

As above shown, this small balance per passenger-mile yields but 3.42 per cent on the investment as recorded on the books, or 2.35 per cent on the appraised cost, either of which is far below a fair return.

There being two general classes of passenger fares, mileage-ticket and straight-ticket and miscellaneous, an inquiry into each is necessary in order that any increase may be placed where it equitably belongs.

PROPOSED INCREASE OF PASSENGER RATES

The evidence given above demonstrates that the average actual cost per passenger mile in 1914, exclusive of a return on the investment, was 2.32 cents, or largely in excess of the 2-cent mileage ticket rate. Stated differently, the portion of the public that is traveling at the 2-cent ratio is carried at a distinct loss, while the revenue obtained from all passengers yields a return that is grossly inadequate.

TABLE 8—EFFECT OF INCREASE IN MILEAGE-TICKET RATE, BASED ON 1914 RESULTS

	Passenger Fares	Total Passenger Service	Freight Service	Grand Total Pass. and Frt. Service
Existing net income after making suitable provision for deferred maintenance, etc.	$65,905	$38,989	$165,596	$204,585
Proposed increase in passenger mileage-ticket rates from 2c. to 3c. per mile	53,450	53,450	0	53,450
	$119,355	$92,439	$165,596	$258,035
Rate of return on book cost, per cent	6.19	3.88	4.63	4.33
Rate of return on appraised cost, per cent	4.25	2.67	3.15	2.96
Operating ratios, per cent	75.6	84.1	71.9	76.8

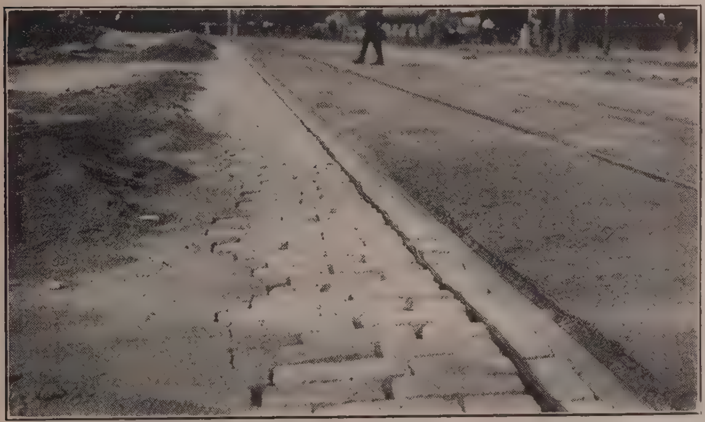
Under these circumstances the least that can be done is to raise the mileage-ticket rate from 2 cents to the straight-ticket rate of 3 cents per mile, the effect of which, based on 1914 results, is shown in Table 8 on the preceding page.

Summarizing, the increase in the passenger mileage-ticket rate from 2 cents to 3 cents per mile, based on 1914 results, would yield an additional revenue of $53,450, and this would bring down the operating ratio of passenger transportation approximately to the average for all branches of service, would place all passengers substantially on the same basis, would make the rates of return on the investment devoted to passenger and freight service more nearly alike, and would still leave the return to the owners of the property well below a fair rate.

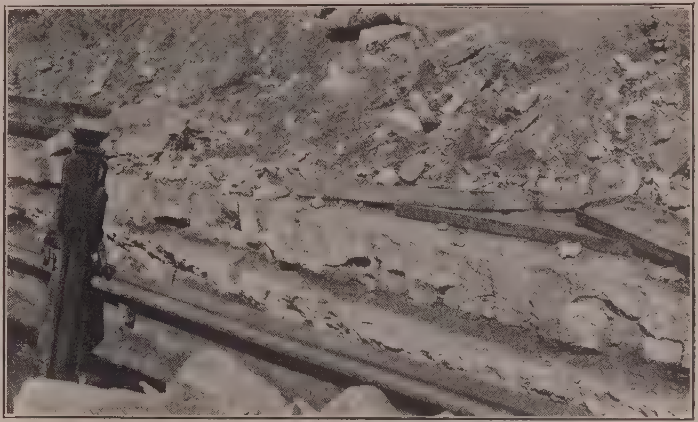
Track Renewal Discloses Perfect Condition of 14-Year-Old Granite Pavement

Two-Thirds of the Grouted Blocks on Main Street, Worcester, Could Be Relaid, if City Ordinance Permitted

STREET railway track reconstruction at Worcester, Mass, involving the removal of grouted granite block pavement between the rails and along 2-ft. strips on either side, has disclosed the fact that the pavement is in almost perfect condition in spite of the fact that it has been in continuous service for 14 years with no expenditure for maintenance or repairs except in the case of street openings to reach subsurface structures. The work is being done by the Worcester Consolidated Street Railway on Main Street, between Lincoln Square and Chandler Street. The line is double-tracked, being in the busiest section of the city, and the renewal of rails is being accompanied by the removal of overhead wires feeding the trolley system.



LEFT — EXPANSION STRIP BREAKS BOND BETWEEN TRACK AND PAVEMENT



RIGHT — BOND OF GROUT INTACT AND SAND CUSHION IN PLACE AFTER FOURTEEN YEARS

In 1901 Main Street was paved with grouted granite block at a cost of about $3.50 per square yard. The pavement, it is claimed, is the oldest of its type on any business street in the country. At that time the company put down a track with the Pennsylvania Steel Company's Section 222 95-lb. girder rails, 8 25/32 in. high, laid on 7-ft. ties.

Granite Shows Little Wear

The small amount of wear shown by the pavement upon the removal of the grouted blocks from between the rails and from the strip outside each track is indicated by the accompanying illustrations. The joints between the granite and the grout are smooth. The blocks are well-shaped, sharp at the edges, and if desired, about two-thirds of them could be used a second time. The street surface retains enough roughness to prevent slipping of horses, and Frederick A. McClure, city engineer, states that during the entire life of the pavement the maintenance expense has been nil, except where the surface has been opened on account of other construction work. Both between and outside the tracks the pavement is in perfect condition, and only the rail wear has made it necessary to replace the granite blocks between and just outside the tracks. The blocks not to be used in paving again are transformed into crushed stone by the company and find a valuable place in the manufacture of concrete used in the reconstructed track.

New Trackwork Details

The new track consists of the Pennsylvania Steel Company's section 273, 9-in. girder rail, weighing 125 lb. per yard and laid in 50-ft. lengths. The rails are of Mayri steel, rolled from special Cuban ore, and the track bolts are of the same material. The rails are laid on 6-in. treated chestnut ties, 8 ft. long, with a minimum face of 7-in., the ties being spaced 2 ft. apart on centers. Rail braces are provided on alternate ties and the joints are of the suspended type, with 12-hole plates. The track bolts, 1 in. in diameter, are provided with 1/16-in. raised threads and Harvey grips, and are of high elastic limit, having a guaranteed tensile strength of 100,000 lb. per square inch. The bolts are forced home to the above limit in putting on the plates. Each joint is provided with two compressed-terminal American Steel & Wire Company's copper bonds, one being 3 in. and the other 10 in. long, giving full rail section conductivity. A 500,000 circ. mil cable is bonded around all special work. Cross-bonding is done every 500 ft. The rail is laid mainly at night after traffic has ceased, one track being available for the use of a derrick car.

The removal of overhead feeders required the building of a conduit under the easterly track, and the excavation for the trench is 5 ft. deep and 30 in. wide at the bottom. Orangeburg fiber duct 3.5 in. in inside diameter is installed, the line carrying 30 or 36 ducts according to location. Both positive and return feeders are to be drawn in, and the duct area provides for future cables and for rentals.

No track ballast is required, an excellent gravel foundation being available throughout the work. The ties are laid upon a bed of gravel, which is leveled to within 3 in. of the top of the tie. Concrete of 1 part cement, 3 parts sand and 6 parts crushed stone is poured around the ties to a total depth of 5 in., thus surrounding the base of the rail. On top of the concrete a 1-in. cushion of sand is placed, the paving blocks being bedded upon this by the city. The blocks are laid about ¼ in. apart and are grouted with a mixture of 1 part cement and 2 parts sand until the tops of the blocks are nearly reached, when a 1.25 : 1.5 mixture is used. A dressing of pea stone is then broomed upon the granite. The job was begun July 6 and is to be completed early in September.

Experiment with Felt Strip to Separate Track from Pavement

Between Lincoln Square and School Street a strip of felt 6 in. wide and ½ in. thick has been placed vertically between a row of blocks laid parallel to the outer rail of each track and the heads of the other paving blocks laid on the street, the axes of the latter being at right angles to the rail. These strips are designed to reduce the noise of the cars by the insertion of a break between the track and the solid structure formed by the paving blocks and the grouting. Pending a test as to the watertightness of this construction, it has been decided to omit it in the balance of the job, as it was introduced largely as an experiment. The opinion is held in some quarters that with the felt strip in service it may be difficult to prevent water from getting between the block and the rail and ultimately reaching the ties, and the space required by the rail braces prevents the application of a continuous strip of felt between the rail and the first row of blocks.

Work is pushed day and night and the maximum number of men employed by the company is about 500. The city force engaged in laying the blocks, grouting and cleaning totals about 22. All materials are hauled to the job by the company, the prin-

OLD PAVEMENT TOOTHED READY FOR LAYING OF NEW BLOCKS

RELAYING BLOCKS BETWEEN OLD PAVEMENT AND RAILWAY TRACK

cipal storage yard being at Greendale, 3 miles north. An electrically operated side-dumping car built for the company by the Wason Manufacturing Company of Springfield, Mass., is in use for the delivery of stone, sand, etc. Very little storage of materials is required on the street, the teaming space on each side of the track being left practically free. Concrete is mixed on the street in a Standard portable mixer, gear-driven by a 5-hp. 550-volt motor supplied from the trolley by a flexible cable and contact pole, the machine having a capacity of about 15 cu. yd. per hour. A gasoline engine driven mixer prepares the grout and all water used is metered at the hydrant.

Blocks Removed with Chisels and Sledges

In removing the paving the joints are attacked by bull point chisels and 16-lb. sledges. Picks are then run under the paving blocks and the sand pulled out. The blocks are then broken off, singly or in groups, by sledges, and are removed to the side of the street. The grout is in excellent condition despite its 14 years' service, and is crushed and screened with the blocks used to provide ¾-in. broken stone for concrete. About 200 sq. yd. per day can be ripped up by 75 men. The blocks are hauled to Greendale, sorted, and about 50 per cent are crushed, the remainder being available for repaving of gutters or between tracks in other parts of the system. If necessary 60 to 70 per cent of the blocks could be salvaged for reversible re-paving, for their faces are practically as good as when laid. In laying, one man can put down about 50 sq. yd. per day.

The fiber conduit is laid on a concrete base 3 in. thick and each duct is surrounded by about 1 in. of concrete.

Jacks are employed to loosen the rail from the concrete base, which can easily be broken by hammers. Old spikes are sent to the scrap pile. The grouted surface is closed for one week to automobiles and teams after completion. Fred Wilkinson, roadmaster of the railway company, states that crushed stone could not be purchased and delivered on the job for less than $1.50 per ton, and the value of the old block being about 40 cents per ton, including crushing and haulage to the job, the cost of utilizing the old block is but 38 cents per ton. Good blocks can be cleaned of grout scale at a cost of 1 cent each.

In speaking to a representative of the Engineering Record Mr. McClure emphasized the importance of using a paving block of a fairly soft character, pointing out the value of Milford, New Hampshire, granite for this service. The pavement at Worcester gave no trouble to speak of, although no expansion joint was provided. Dry sand and thin grout are also essential to the best results. Were it not for a city ordinance requiring new blocks in paving many of the 14-year-old blocks taken from the present job would afford good material for a second laying.

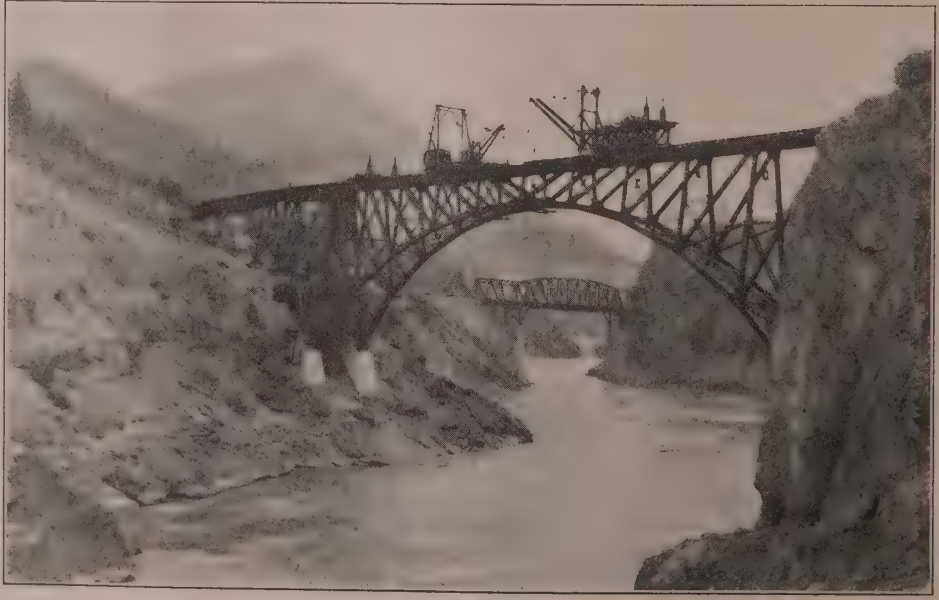
First Train Service Over Transcontinental Railway

THE FIRST regular train schedule has just been established on the Canadian Northern Pacific Railway between Pacific tidewater at Port Mann, B. C., and Hope, 78 miles east. The ballasting of the line as far east as Kamloops is practically finished and north of Kamloops to Yellowhead Pass the work will be completed by the end of August. The entire line from the Pacific Coast to Quebec should be in operation, the chief engineer's office reports, late this summer.

The British Columbia section of the line, which was described in the Engineering Record of June 6, 1914, has involved very heavy construction and expense has not been spared in the endeavor to secure a line through the mountains on a low grade. The average cost of the 500 miles in British Columbia has been about $70,000 per mile, and in one instance grading for a mile of track, including a 548-ft. tunnel cost $326,000 and involved the removal of 250,000 cu. yd. of material.

In British Columbia there are twenty steel bridges and viaducts on this line. The one of bridge 1, shown in the accompanying view and on the front cover, spans the Fraser River 5 miles below Lytton at a point where the stream is so swift and deep that only the type of bridge that can be constructed by the cantilever method was considered practicable. The through bowstring truss shown in the background on the line of the Canadian Pacific Railway, was erected without falsework as described in the Engineering Record of Jan. 17, 1914.

Hypochlorite Conversion Tables, devised by the engineering department of the Denver Union Water Company for calculations after each hourly reading, disclose the fact that the amount of hypochlorite applied hourly in pounds per million gallons of water per day, the latter a nomenclature recommended by the New England Waterworks Association in preference to grains per gallon or parts per million, is nearly identical with the calculated parts per million of available chlorine when the latter is 36 per cent of the total amount of hypochlorite used. For example, when 0.30 lb. is applied hourly to a weir box on which the reading is 1,000,000 gal. daily, the equivalent parts per million of available chlorine is 0.31.



COMPLETING FRASER RIVER BRIDGE FOR NEWEST TRANSCONTINENTAL RAILWAY

Slope-Deflection Method Reduces Time for Wind Stress Analysis

Effect of Horizontal Shear in Building Frames Compared in Approximate and Accurate Computations by W. M. Wilson and G. A. Maney

THE well known inaccuracy of the usual methods used in the practical analysis of steel building frames for wind stresses has been made the subject of an extensive study by W. M. Wilson, assistant professor of structural engineering, University of Illinois, and G. A. Maney, at that time research fellow in the department of mechanics, whose findings are published in Bulletin 80 of that institution. The exact determination of all the stresses in a steel frame due to horizontal shear, the authors point out, is practically impossible, but they present an analysis based upon assumptions which are not exactly true, but which allow the application of an improved slope-deflection method which they believe is more accurate than the methods ordinarily used. A short, practical approximate method is proposed, an example given and comparisons made with the results obtained by using four usual approximate methods and assumptions. A complete discussion of results and of the effects of assumptions is a valuable conclusion to the bulletin.

It will be possible to give in this abstract only an outline of the accurate analysis used, the fundamental assumptions and the equation upon which it is based, the modifications proposed for a shorter approximate method, and the conclusions and results of the comparison with the ordinary practical methods.

CLASSIFICATION OF METHODS

Methods of calculating wind stresses in office buildings may be divided into two classes, approximate methods used in the actual design of buildings, and exact methods which are the results of attempts to make an accurate analysis of the stresses. The three approximate methods in current use are based upon the following different assumptions, but in all cases the point of contraflexure of the column is assumed at mid-height of the story:

Method 1.—A bent acts as a cantilever, the point of contraflexure of the girder is at its mid-length, and the direct stress in the column is proportional to its distance from the neutral axis of the bent.

Method 2.—A bent acts as a series of portals (each interior column acting as a member of adjacent portals will therefore have a resultant direct stress of zero), and the shear is the same on all columns of a story.

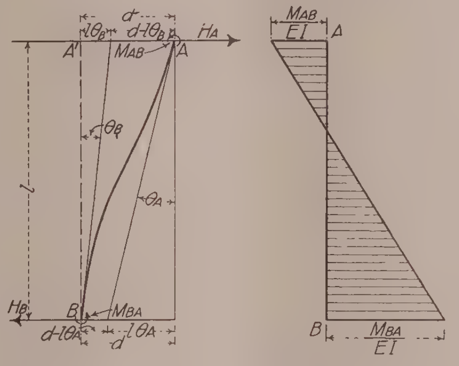
Method 3.—A bent acts as a continuous portal, the direct stress in a column is proportional to its distance from the neutral axis of the bent and the shear is the same on all columns of a story.

Prof. Albert Smith in a paper in the *Journal* of the Western Society of Engineers, vol. 20, page 341, describes a fourth approximate method which is based on the same assumption as method 1, except that the last assumption as to direct stress in the column is replaced by an assumption that the shears on the internal columns are equal and that the shear on each external column is half that on the interior columns. This is called method 4.

Three exact methods have heretofore been used. A method which takes account of the elastic curves, the deflections, and changes in length of the members is used by Dr. C. A. Melick in Bulletin 8 of the University of Ohio. A method which uses the deflections of the columns and the changes in slope of the tangents to the elastic curves of the columns and girders at their points of intersection is used by E. F. Johnson in the Transactions of the American Society of Civil Engineers, vol. 55, page 413. The method of least work is applied by Prof. Smith in the Bulletin above mentioned. All of these methods are long and difficult in application.

OUTLINE OF PROPOSED EXACT METHOD

The proposed analysis is based upon the following assumptions: 1.—The connections between the columns and girders are perfectly rigid. 2.—The change in the length of a member due to the direct stress is equal to zero. 3.—The length of a girder is the distance between the neutral axes of the columns which it connects and the length of a column is the distance between the neutral axes of the girders which it connects. 4.—The deflection of a member due to the internal shearing stresses is equal to zero. 5.—The wind load is resisted entirely by the steel frame.



FUNDAMENTAL RELATIONS AND NOTATION

Based upon these assumptions, an analysis of the stresses can be made by applying certain fundamental principles of mechanics to obtain equations from which the stresses in the frame can be determined. Consider the point of intersection of the neutral axes of a column and a girder as a free body in equilibrium under the action of the moments at the extremities of the columns and girders which intersect at that point. It is shown later that each of these moments may be expressed in terms of the changes in the slope at the extremities of the members and the deflection of one end of the member relative to the other end. A moment equation can therefore be written for each point where the columns and girders intersect, and the only unknown quantities will be the changes in the slopes at the extremities of the columns and the horizontal deflections of the columns in the story considered.

If all of the columns of a story be taken together as a free body, the sum of the moments at the two extremities of all of the columns will be balanced by a couple whose moment is equal to the total shear on the story multiplied by the story height. This added condition then makes it possible to write as many equations for each story as there are columns in the story, plus one. As the only unknown quantities in these equations are the changes in the slopes at the extremities of the columns and the deflection in a story common to all columns, there are as many equations per story as there are unknowns.

By solving these equations the slopes and the deflections can be determined. Knowing the slopes and deflections, the moments can be computed. Since the product of the shear on a member and the length of the member is equal to the algebraic sum of the moments at the extremities of the members, the shear can be computed. With the shears known, the direct stress in any column can be determined by taking the column as a free body and equating the sum of the vertical forces to zero.

By thus reducing the number of unknown quantities through the use of the slopes and deflections as unknowns instead of the direct stresses and moments, the problem is very much simplified.

DERIVATION OF FUNDAMENTAL EQUATION

The fundamental equation for the relation between the bending moment at one end and the slopes of the tangents to the neutral axes at each end and the deflection of the member is based upon the relation shown in the accompanying figure, on which the notation is indicated. Consider a member which is not acted upon by any external forces or couples except at the end. The line AB represents the neutral axis of such a member. The moment at A is represented by M_{ab} and the M/EI diagram is shown on the right of the figure. The deflection of A from the tangent at B is seen to be $d - l\theta_b$. Equating this to the fundamental deflection equation $y = \int Mxdx/EI$, as given in texts on mechanics, substituting the general equation for bending moment $M = M_{ab} + (M_{ba} - M_{ab})x/l$, integrating and solving for the deflection d, there results for E and I assumed as constants:

$$d = l\theta_b + (2M_{ba} + M_{ab})l^2/6EI$$

By analogy, with due regard for signs, the following equation can be written, based upon the deflection $d - l\theta_a$ of B from the tangent at A:

$$d = l\theta_a - (2M_{ab} + M_{ba})l^2/6EI$$

These two equations can be used to solve for M_{ab}, giving the following important equation:

$$M_{ab} = 2(2\theta_a + \theta_b - 3d/l)EI/l$$

This equation is then applied as above indicated to obtain general equations for any story of either symmetrical or unsymmetrical bents. Tables are given for cases of one to five spans for either symmetrical or unsymmetrical bents.

PROPOSED APPROXIMATE METHOD

The proposed approximate method is based upon the following assumptions in addition to those used in the slope-deflection method: 1.—The changes in the slope at the top of a column in the story above and in the story below the one in which the stresses are to be determined are equal to the change in the slope at the top of the corresponding column in the latter story. 2.—The ratio of the deflection to the length of the columns in the story above the one in which the stresses are to be determined is equal to the ratio of the deflection to the length of the columns in the latter story.

The application of these assumptions to the general equations results in a large reduction in the number of unknown quantities, and a corresponding simplification of the computations.

COMPARISON OF RESULTS

Application of the above exact and approximate methods and of the approximate methods 1, 2 and 3 was made to a twenty-story bent of three spans with short middle span. The tabulated results for the moments in the case of this symmetrical bent show: First, that the moments determined by methods 2 and 3 are very seriously in error; second, that the moments determined by method 1 and by the proposed approximate method agree very closely with the moment determined by the exact slope-deflection method except at points where there are sudden changes in the members of the bent; third, that the errors in the moments determined by the proposed approximate method are less for the girders than for the columns.

Application was also made to a symmetrical three-span bent with long middle span, with the result that the moments determined by the proposed approximate methods are as accurate as before, whereas the moments determined by method 1 are inaccurate, and those determined by methods 2 and 3 are very inaccurate. Other studies were made to determine the effect of the proportions of a bent upon the accuracy of method 1, and the accuracy of the approximate method when the moment of inertia of the girders is proportional to the bending moment.

A test was made of a celluloid model of a bent to compare with the results of analytical computations. The calculated quantities were found to be, in general, greater than the observed quantities. This was explained by the fact that the length of a member was taken equal to the distance between center lines, whereas the length that is actually free to bend is the distance from outside to outside of the members. In general, however, the agreement was quite close, and the test supports the theory upon which the slope-deflection method is based.

CONCLUSIONS

As a result of the investigation, the following conclusions are drawn:

1. Approximate methods 2 and 3 are so inaccurate that they should never be used; approximate methods 1 and 4 are quite accurate in some cases, but they may give results which are seriously in error.

2.—The method presented and designated as the slope-deflection method contains no approximations except those in the assumptions. It has been shown that the inaccuracies in the assumptions do not materially affect the results. Therefore the method is quite accurate.

3.—While the slope-deflection method is long, it could be used in the actual design of a building; but it has its greatest value as a standard by means of which the accuracy of the approximate methods may be determined.

4.—The proposed approximate method is short; and, except at points where there are very large changes in the size of the members, gives results which are accurate enough to be used in the actual design of a building.

A ONE-MILE Span on a 110,000-volt transmission line is used in crossing Carquinez Straits near San Francisco, Cal.

$16,000,000 Required for Los Angeles County Flood Protection—Part 2

Channel Improvement Necessary in Lower Reaches while Gravel Tracts Are Urged for Absorbing Flow at Canyon Mouths

IN PART 1 of this article the general problem of flood prevention and protection in Los Angeles, as presented in the general report of the Board of Engineers, Flood Control, was considered, while space was also given to Mr. Olmsted's special report on the use of impeding dams and rebrushing in the canyons. The second part, concluding the abstract of the report, takes up the special discussions by H. Hawgood, on flood control in the San Gabriel district; by Capt. C. T. Leeds, on control in the Coastal Plains, and by J. B. Lippincott on problems of the San Fernando valley.

Mr. Hawgood on Flood Control in San Gabriel District

In his individual report on a project for dealing with the situation in the San Gabriel district, Mr. Hawgood calls attention to the influence of the torrential storm flows from 322 sq. miles of precipitous mountain country, the highest peak of which, San Antonio, attains an elevation of 10,080 ft. above sea level. Of these 322 sq. miles of mountains, 224 discharge their floods through the San Gabriel Canyon. Below the canyon 12 sq. miles of mountain drainage reaches the San Gabriel River from the west and 49 sq. miles from the east. The Rio Hondo receives the drainage of 37 sq. miles of mountains.

The report properly starts in with a consideration of the fundamental proposition of the maximum volumes of water to be carried by the various streams and the data available for the determination of these quantities. The high-water marks of the 1914 floods place the maximum discharge rate at the mouth of the canyon at 27,000 sec.-ft., and the peak-rate reduction caused by flattening of gradient, by pondage and loss by seepage would reduce the maximum rate to approximately 22,000 sec.-ft. at the head of Lexington Wash, where the river divides. In considering the discharge of the Rio Hondo it is pointed out that a relatively high value must be given to the runout per unit of area on account of the ever increasing concentration following upon the growth of town improvements, such as street paving and storm drains.

DISCHARGE FORMULA

Mr. Hawgood does not accept any existing formula for determining the maximum discharge rate, because many of the elements, such as porosity of soil, character and extent of vegetation, etc., do not admit of mathematical expression, other than by a coefficient more or less arbitrary. There are however certain general controlling elements which do admit of mathematical expression. These are: (1) area of drainage, (2) shape of drainage area, (3) slope of drainage area, (4) rainfall.

The shape of the drainage area and its position in relation to the outlet play an important part in the rate of discharge. A triangular area with the outlet at the apex would have its center of gravity twice the distance from the outlet, as when the same triangle is turned through 180 deg. and discharges along its base. The rate of discharge is a function of the distance which the water must travel to the outlet. The distance from the center of gravity of the drainage figure to outlet may with reason be assumed to be the main distance of travel. Changes in the position of the center of the gravity will increase or decrease that distance and inversely the associated discharge rate. Hence it is obvious that any rational formula must take cognizance of the form of the drainage area. After a critical study of the subject Mr. Hawgood has developed the following formula:

$$D = C\,R\,\frac{\sqrt{s}}{2l}\left[\frac{4\sqrt{A}}{\sqrt{l+(A/L^2)^2}}\right]$$

in which D is the maximum rate of discharge in second feet per square mile of area drained; A, the area drained in square miles; L, the extreme length of drainage in miles; l, the distance of center of gravity of drainage area figured from the outlet; S, the slope of drainage area $=$ (fall $\div L$); R, the average rainfall in inches per hour during the time required for water to flow from the most remote part of the drainage to the outlet and during the hour of maximum precipitation; C, a coefficient determined from observation.

APPLICATION OF FORMULA

In the application of the formula to the San Gabriel tributaries, values of R have been based upon intensive rainfall at Pasadena, Feb. 18, 1914, a graph of which is presented in the report.

A value of 2000 was found to be an average for C.

The formula is not designed to include certain areas involved with questions of melting snow and of such length that the time of the flow from their uppermost points to their outlets are matters of several hours, which renders the rain question complex. To have carried these factors into the formula would have destroyed its present simple slide-rule form without commensurate benefit at this time.

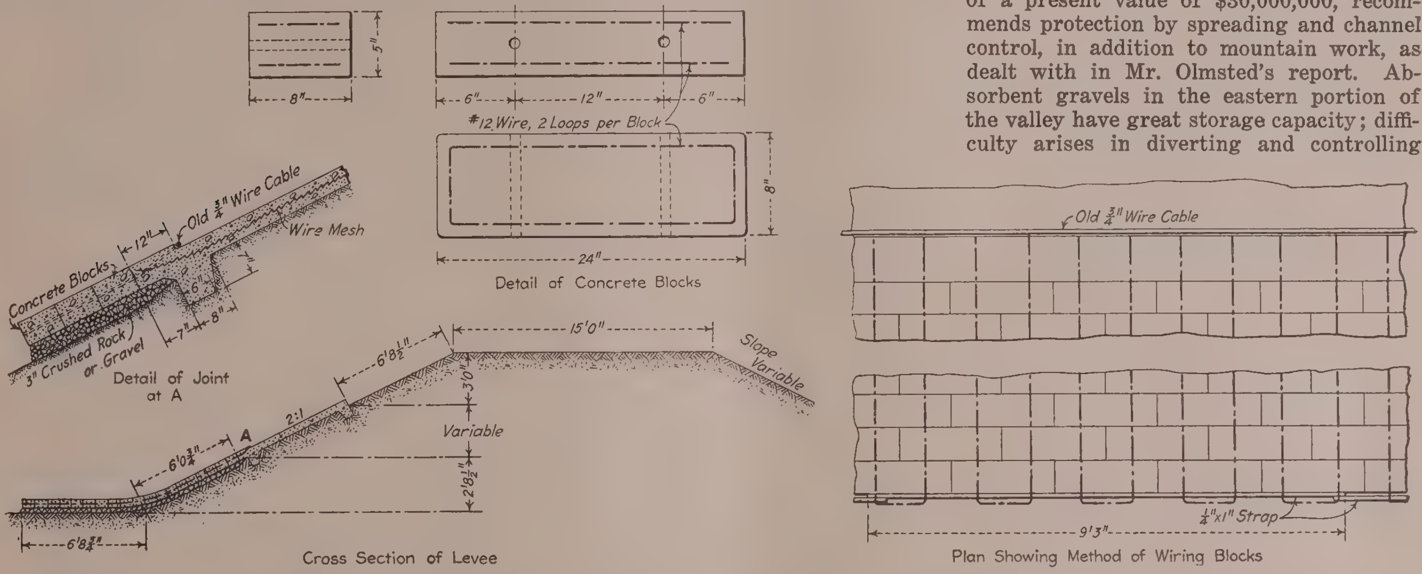
A table giving a comparison of computed and observed discharge rates per unit of area shows that the computed and observed discharges are in more than fair agreement. It is not unreasonable to say that local variations of rainfall might readily have had range sufficient to cause such differences as appear in the table, as, in the computation, the Pasadena gagings had to be applied to other territory in which no gagings were taken.

WORK AT HEADWATERS

The importance of conservation of water as an economic factor in flood control work is strongly emphasized, both from the viewpoint of putting conserved waters to beneficial use and that of permitting reduction in size and cost of channels for carrying surplus waters harmlessly to the sea. The necessity of greater knowledge of rain distribution in the mountain areas through the establishment of rain gages and stream measurements is pointed out. Mention is made of the primary effect of the introduction of check dams in reducing the natural velocity of the streams and the secondary effect in reducing the erosive and transporting power of the streams and, as a corollary, inducing sedimentation.

Although check-dam ponds fill with detritus, the interstices of the filling, constituting 20 to 40 per cent of the mass, form valuable storage. The raising of the streambed and its water plain will add to the sponge large masses of pervious material now above water line. The water thus stored may or may not have more than a limited effect on reduction of the flood discharge. The maximum discharge often comes after a period of gentler rains whose run-off may have already soaked the gravel beds to a large extent, but the effect of this underground storage is of the greatest importance in enhancing summer flows.

Mr. Hawgood is of the opinion that a reduction of 20 per cent or more can be accomplished by the well-studied use of check dams. To this is to be added the reduction brought about by "spreading" on the debris cones outside the mountains. Brush is better for water conservation than tree planting. Retardation work in the mountains should be prosecuted to its full practical limit and the levee and channel work which will in any event be necessary in the valleys thereby relieved as much as possible.



Detail of Joint at A

Detail of Concrete Blocks

Cross Section of Levee

Plan Showing Method of Wiring Blocks

DETAILS OF LEVEE CONSTRUCTION, AND CHANNEL PROTECTION BY CONCRETE BLOCKS, WIRED TOGETHER TO INSURE STABILITY

FLOOD-CONTROL STRUCTURES

A second section of the report is devoted to flood-control structures and work, taken up in the form of detailed discussion of the problem of each individual drainage area. In the San Gabriel a probable maximum flood rate of 45,500 sec.-ft. could be reduced 20 per cent by check dams in the higher and smaller waterways, and be further reduced by diversion of part of the flow at the canyon mouth onto spreading grounds, so as to give a maximum flow in the improved channel immediately below the canyon mouth of about 31,000 sec.-ft., which would be reduced to about 29,000 sec.-ft. at the head of Lexington Wash by percolation in the very pervious bed above this point. At Lexington Wash 12,000 sec.-ft. would be diverted into the Rio Hondo and 17,000 sec.-ft. into the old channel.

Section 3 of Mr. Hawgood's report is devoted to flood control works and estimated costs. Channel excavation costs are estimated on the use of steam shovels for the narrower channels and drag-line scrapers for the wider channels. Levee protection is based on the use of hand-laid boulders where available in the upper portion of the channels, with a mound about 10 ft. wide of loose boulders deposited along the toe of the levee to sink into and fill any cavities caused by erosion. Where boulders are not available 4-in. concrete-slab protection, ribbed on the under side to check slipping over the upper half of the levee slope, with articulated concrete mats over the lower half, and extending as an apron 6 ft. out into the bed of the channel, are recommended. For the smaller channels there is recommended a mat made by laying wire netting on the levee slope and for several feet out over the channel bed, covering the mat with cobbles and small boulders, laying on top thereof other wire netting and wiring bottom and top nets together. Mats of this type have been employed under Mr. Hawgood's direction by H. W. Hanson in Latuna Canyon, between Burbank and Big Tujunga, and are somewhat similar to some successfully used in India. Protection by living growth of bamboo is particularly promising, as the bamboo is readily propagated and is of dense growth. Where dikes are to be used, which, on account of their high cost would be rarely, Mr. Hawgood proposes a double row of braced posts of concrete for permanent and important work, and wood for temporary and less important work, carrying pole or brush screens. The space between the posts would be planted to bamboo. In the concrete structures the live bamboo growth will gradually take the place of the perishable pole or brush screen, and will entirely take the place of decayed timber structures.

Captain Leeds on Control in the Coastal Plains

The probable volumes of flood discharge to be provided for in the Coastal Plain are: Los Angeles River, 35,000 sec.-ft.; Rio Hondo, 16,000 sec.-ft.; San Gabriel, 20,000 sec.-ft. Surveys were made and maps executed giving required topographical data of the district. Channel design involves a balancing of the economic factors of channel width, riprap cost, and land cost in country worth from $500 to over $3,000 per acre. In the district where land is most valuable a narrow, deep trapezoidal channel with riprap is recommended. Where velocities will be lower, articulated concrete-block protection, and at other points a wide channel with berms, are determined by local conditions. Levees can be oiled on top and protected by plantings. Extended consideration is given to various forms of levee protection.

After treating the erosive power and debris transportation characteristics of the streams Captain Leeds dwells at length on the economic importance of protecting the harbor. Flood history, the economic importance of the harbor, and an analysis of possible plans lead to the recommendation of a diversion at Dominguez to Alamitos Bay, south of the harbor district.

Mr. Lippincott on San Fernando Valley Problems

Mr. Lippincott, in his special report on control of waters in the San Fernando Valley, where floods menace affects property of a present value of $30,000,000, recommends protection by spreading and channel control, in addition to mountain work, as dealt with in Mr. Olmsted's report. Absorbent gravels in the eastern portion of the valley have great storage capacity; difficulty arises in diverting and controlling enormous flood peaks. The report proposes acquisition of a spreading tract of 3135 acres in the eastern portion, and control and protection of channels by levees and planting, utilizing Phoenix Canaryeusis or common date palm, to be set in four rows, 6 ft. apart, trees spaced every 10 ft. The cost would be about $1,000 per mile, of planting, including care to establish growth.

The western portion of the valley can be protected by channel control of the smaller floods. Important studies deal with the control of the Los Angeles River in the lower portion of the valley. Tree growth in the channel at present offers serious obstruction, and should be grubbed out. Natural growth on the sides should be augmented by planting. Portions of the bank will require riprap protection. Estimates total $2,150,000 for protecting the district.

A second report by Mr. Lippincott is a preliminary study of the Arroyo Seco flood channel and its development as a parkway between Los Angeles and Pasadena, making a flood channel of 300 ft. minimum width, and a parkway with irregular boundaries determined by existing property lines, using many small holdings entire, rather than acquiring mere slices of land. Bank protection proposed is similar to that used by the San Pedro, Los Angeles & Salt Lake Railway, of granite fragments dumped loosely along the banks, planted with shrubs and vines to blend with the landscape.

[THE END]

Five Examples of Cantilevered Auditorium Balconies

Several Types of Long Span Cross-Girder May Be Employed to Reduce Number of Columns, Which Obstruct the View

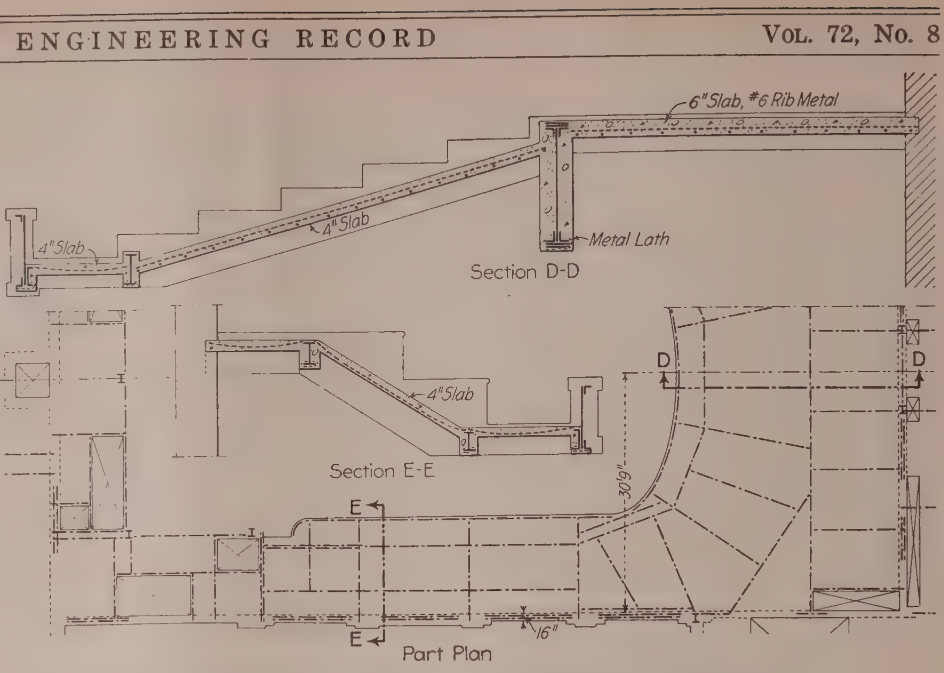
IN THE design of cantilevered balconies for auditoriums the most difficult feature is the main cross-girder. As it is desirable to use as few columns as possible this girder must generally be designed for long spans, but as the long-span girder must also be given sufficient depth to develop an adequate resisting moment, it may in cases form an obstruction more objectionable than if a greater number of columns had been used. As the depth of girders can be decreased below the economical figure by increasing the flange area, if structural steel be used, or by increasing the amount of reinforcing steel and widening the compression part, if the material be reinforced concrete, the designer must make several layouts, keeping in mind economy of design and avoiding obstructions in the form of columns or too deep girders. The five following examples illustrate various solutions of the problem.

COMBINATION CONSTRUCTION

One of the accompanying drawings shows the design of the auditorium balcony in the high school at Montclair, N. J., for which Starrett & Van Vleck were the architects. It is a typical example of construction employing a combination of structural steel and reinforced concrete. The main girder has a span of 61½ ft.

In the high school at Stamford, Conn., for which Boring & Tilton were the architects, a very light type of combination balcony construction was used. As columns were permitted at fairly small intervals 12-in. beams were used to support the steps, which were built directly on top of 10-in. 30-lb. beams, spaced 5 ft. on centers and anchored in the walls. The step construction was very light and consisted of 24-gage seven-rib Hy-Rib plastered on both sides so that the total thickness of the slab thus formed was 3 in. The Hy-Rib was fastened to 3 x 3 x ¼-in. angle bars, as shown in the detail drawing.

The combination type was also used in the high school at Mount Vernon, N. Y. The steps for the seats are supported on the exterior walls and on two steel cantilevered girders having an overhang of about 19 ft. These cantilevers are spaced 15 ft. on centers and their distances from the exterior walls are about 21 ft., so that the risers of the concrete steps are continuous beams with 21-ft. end spans and a 15-ft. center span. Here Hy-Rib has also been made use of for the building of the 3-in. slabs forming the treads, so as to save the cost of wooden forms. Such forms, however, could not be entirely eliminated, as the risers are reinforced-concrete beams, which had to be built in the usual way. The design is shown in one of the accompanying drawings. Starrett & Van Vleck were the architects.

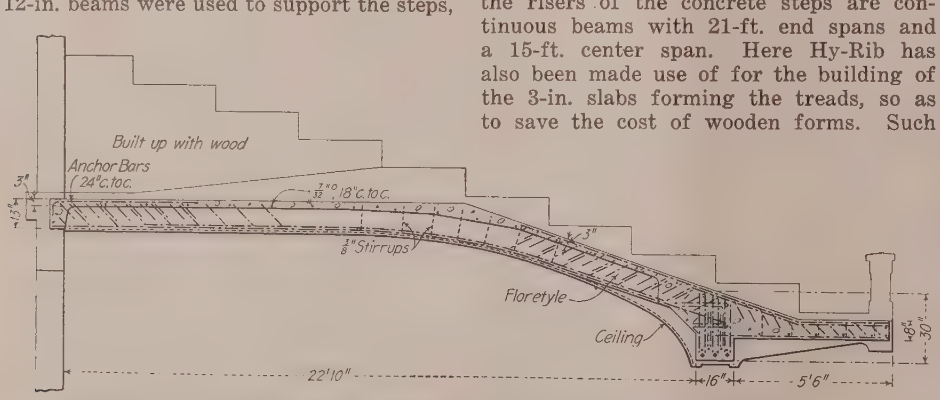


PLAN AND SECTION OF BALCONY IN HIGH SCHOOL AT MONTCLAIR, N. J.

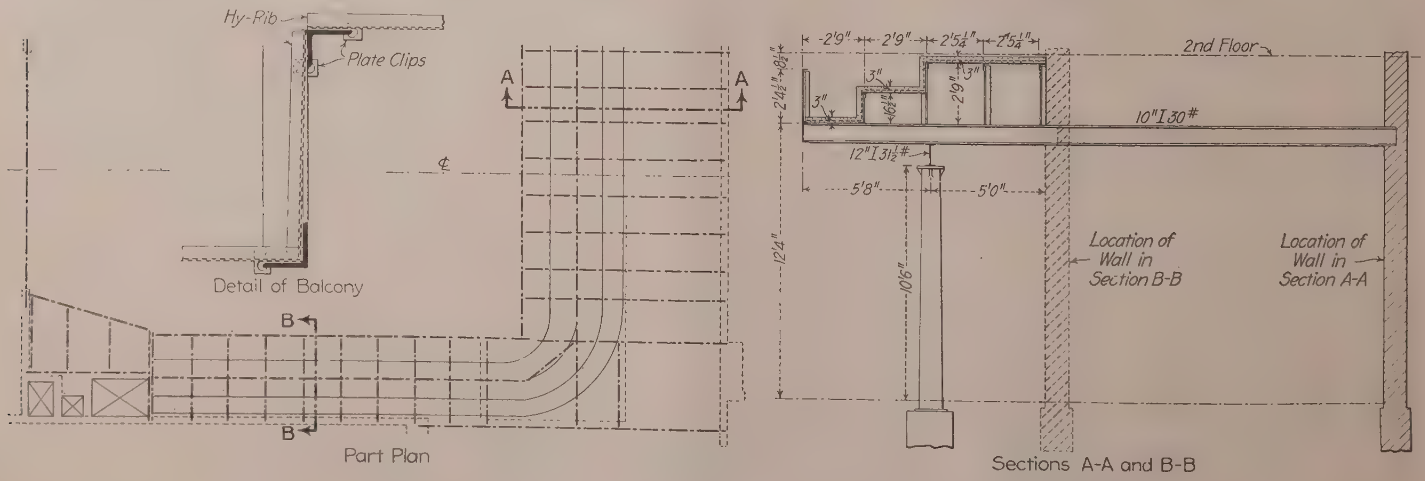
REINFORCED-CONCRETE CONSTRUCTION

In the design of reinforced-concrete cantilevered balconies the main difficulty is to find place for the widening of the compression side of the main girder, in case it is necessary to cut down its depth below the economical. An example of this type of construction is found in a school building at Southampton, N. Y., of which Hewitt & Bottomley were the architects. The girder spans 39 ft. and supports the seat tiers by means of two cantilevers, spaced 14 ft. on centers. The overhang of these cantilevers is 7 ft. and the anchor arm 13 ft. 5 in. The seat tiers are of wood. As shown in the drawing, a 6-in. slab has been built at the lower edge of the cantilevers, forming a ceiling and covering the construction.

When the balcony for the school at Torrington, Conn., was to be built the design was changed somewhat from that used at Stamford. As the total span of the main girder, 53 ft., was too long, it was divided, by using two columns, into two 11½-ft. side spans and one 30-ft. center span. The steps were made of wood and were placed directly on a cantilevered floor con-

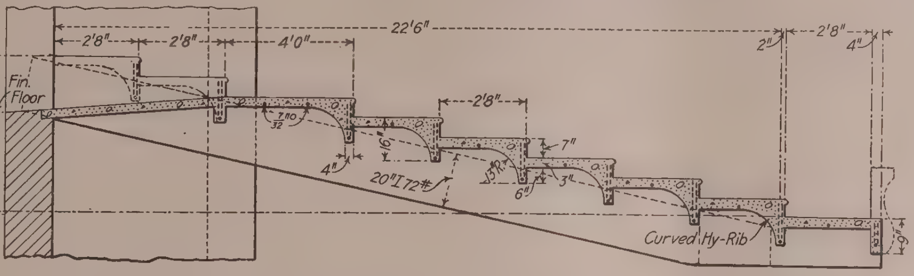


BALCONY OF REINFORCED CONCRETE FOR THE SCHOOL AT TORRINGTON, CONN.

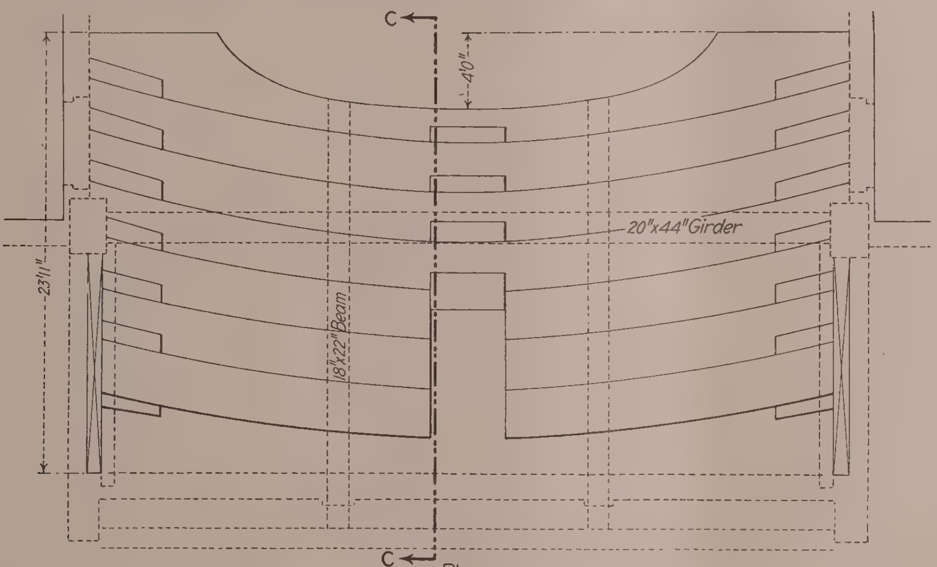


PLAN AND SECTIONS OF LIGHTTYPE COMBINATION BALCONY CONSTRUCTION AT STAMFORD, CONN.

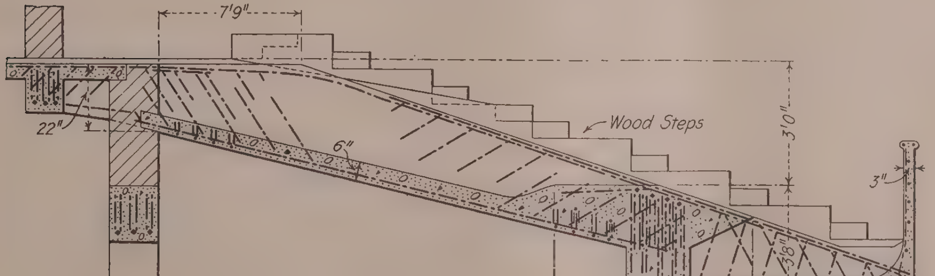
sisting of an 8-in. overhanging slab projecting 5½ ft. in front of the girder, and a T-beam floor construction between the girder and the rear wall. The latter portion serves as the anchor arm. The T-beams were formed by 10-in. Floretyles, spacing the beams 25 in. on centers. The slab between these beams is 3 in. thick. The distance from the main girder to the wall is 22 ft. 10 in. and the total depth of the floor construction is 13 in. The underside of the structure is covered by a ceiling formed of Hy-Rib to which a coat of plaster was applied. The architect for this building was Wilson Potter.



DESIGN OF BALCONY BUILT IN THE HIGH SCHOOL AT MOUNT VERNON, N. Y.



Plan



Section C-C

REINFORCED-CONCRETE BALCONY CONSTRUCTION AT SOUTHAMPTON, N. Y.

The reinforced-concrete portions of the above balconies were designed in the office of Herman Fougner, New York representative of the Trussed Concrete Steel Company of Detroit.

SAFETY LANES FOR PEDESTRIANS have been painted upon the pavement at Fifth Avenue and Forty-second Street, New York, to minimize traffic accidents. The lanes indicate the proper places for crossing and strict measures are being adopted to restrict vehicles from these areas.

Pile Tests Indicate Type of Substructure for Technology Buildings

Apparently Good Spruce Piles Found to Be Broken and Broomed by Peculiar Geological Conditions and Soil Formation—Oak Piles for Hard Material

By CHARLES T. MAIN, Consulting Engineer, and H. E. SAWTELL, Boston, Mass.

VARIABLE soil conditions found by extensive investigation at the site of the new buildings of the Massachusetts Institute of Technology caused the engineers to make a very thorough series of pile tests as a preliminary to the design of the foundations. Features of the design and construction of these buildings were described in the Engineering Record of April 4, 1914, page 393, Nov. 28, 1914, page 578, and June 12, 1915, page 748. This article will describe the effects of the particular gravel and clay conditions encountered upon the piles themselves and their supporting power.

In July, 1913, Prof. W. O. Crosby submitted a report based chiefly on the results obtained from twenty-one borings in the site and just outside its limits. His report shows that the bed rock, found at a depth of 120 to 135 ft. below the surface, appears to be quite level. The overlying materials include in succession boulder clay, blue clay, glacial gravel, silt, peat and artificial surface fill. The thickness of the boulder clay varies from a few feet to 25 or 30 ft. The blue clay is 60 to 100 ft. thick. The glacial gravel ranges from 0 to 35 ft.; the silt from 0 to 18 ft.; the peat is very thin and shows in a few places only, and the artificial filling has a maximum depth of 15 or 20 ft.

CHARACTER OF SOIL

The borings made by Professor Crosby were rather widely separated. Soon after actual work was begun it was found that the character and surface levels of the glacial deposit changed frequently and rapidly. It was therefore thought necessary to make additional borings in the sites of the different buildings. A new set of seventy borings was made, and the character of the underlying soil was shown very clearly by sections through selected borings. Typical soil variations are shown in the diagram on page 236. The glacial deposit, set off by heavy horizontal lines, is seen to range through a considerable variation in thickness, sometimes tapering to practically nothing.

Three test pits were dug to a depth of about 22 ft. in order to check up the wash borings, all being near the western extremity of the plot. Ten concrete test piles and a large number of wooden piles were driven for the purpose of determining further the character, resistance and bearing power of the strata.

CAUSE OF OBSERVED SETTLEMENTS

A considerable part of Professor Crosby's report is devoted to the cause of the observed settlements of structures which surround the new site. In his opinion the settlements are only such as would be expected from a study of the foundations and the underlying earth conditions. It is his belief that, had the foundations of these structures been carried down to the glacial gravel or supported from it, the structures would not have settled to any appreciable extent.

By the term "glacial gravel" is meant that deposit found immediately above the clay, and varying in character from fine sand to coarse gravel. As this was generally well compacted and comparatively near the surface, it was decided to support the Technology foundations upon it wherever practicable. Where this deposit is extremely thin it has become necessary in parts of some buildings to depend upon the clay for support.

The clay found under the glacial gravel is of remarkably uniform character and only slightly plastic. It has been designated as "medium," being neither "stiff" nor "soft" except in a few places. Professor Crosby states that in its normal condition in the ground it is probable that all this clay is devoid of excess moisture, and fairly to be described as stiff. In only a few locations was a hard crust found on either the glacial gravel or the clay.

HOW SETTLEMENT DANGER WAS REDUCED

It has been assumed that if any settlement occurs it will be in the clay. In order to reduce this settlement to a minimum it was decided to spread out the building loads as much as practicable over the glacial gravel. This in turn would still further distribute the loads over the clay bed. It was desired to provide for a wide distribution of load on the gravel in the most uniform manner, with a resulting low pressure per square foot. For this purpose it was decided to use a large number of wooden piles, each sustaining a relatively small load, rather than a few heavily loaded piles. The accompanying figure shows a typical group of piles and the way in which the load is distributed.

This figure shows the piling under a footing resting in 12 ft. of gravel or sand and an assumed spread of the load accomplished by means of angles of distribution measuring 60 deg. with the horizontal. The building loads in this case were reduced to about ¾ ton per square foot on the surface of the clay. This, of course, is in addition to the load of the over-burden already found on the site.

A decision to distribute the load in this way precluded the use of concrete piles. It was found that wood piling would be less expensive than concrete piling. This was due to the fact that the permanent water level was high, making it unnecessary to place more concrete than that required for the foundations to meet the heads of the wood piling. Large piles do not prove economical where flexibility is required for light as well as heavy loads.

TESTS OF PILES

After deciding that wood piles were to be used, it became necessary to make a sufficient number of tests to determine the kind and length to use in different parts of the site. This task was rather difficult, owing to the great variety of soil conditions found, as already noted. The investigations were first carried on largely on the sites of the buildings forming the westerly part of the group, where both spruce and oak test piles were driven.

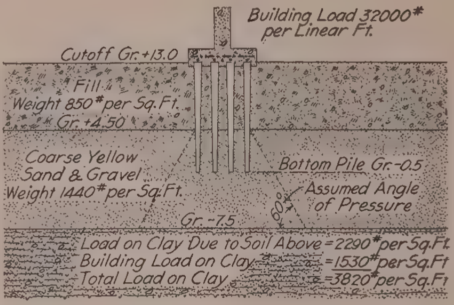
Spruce piles 1 to 10 inclusive were driven into glacial gravel. At these locations this is a well compacted and deep bed of material, commonly known as coarse sand and gravel, with varying depths. Upon being pulled, all these piles were found to be broomed or both broomed and broken. Three of them, Nos. 3, 5 and 7, assumed to be good at the time of driving, were load tested before being pulled. Because of their crippled condition, which was discovered after the tests were made, these results were of no special value except to show how these broomed and broken piles acted under load. The following brief description is given for that purpose.

BROOMING OF SPRUCE PILES

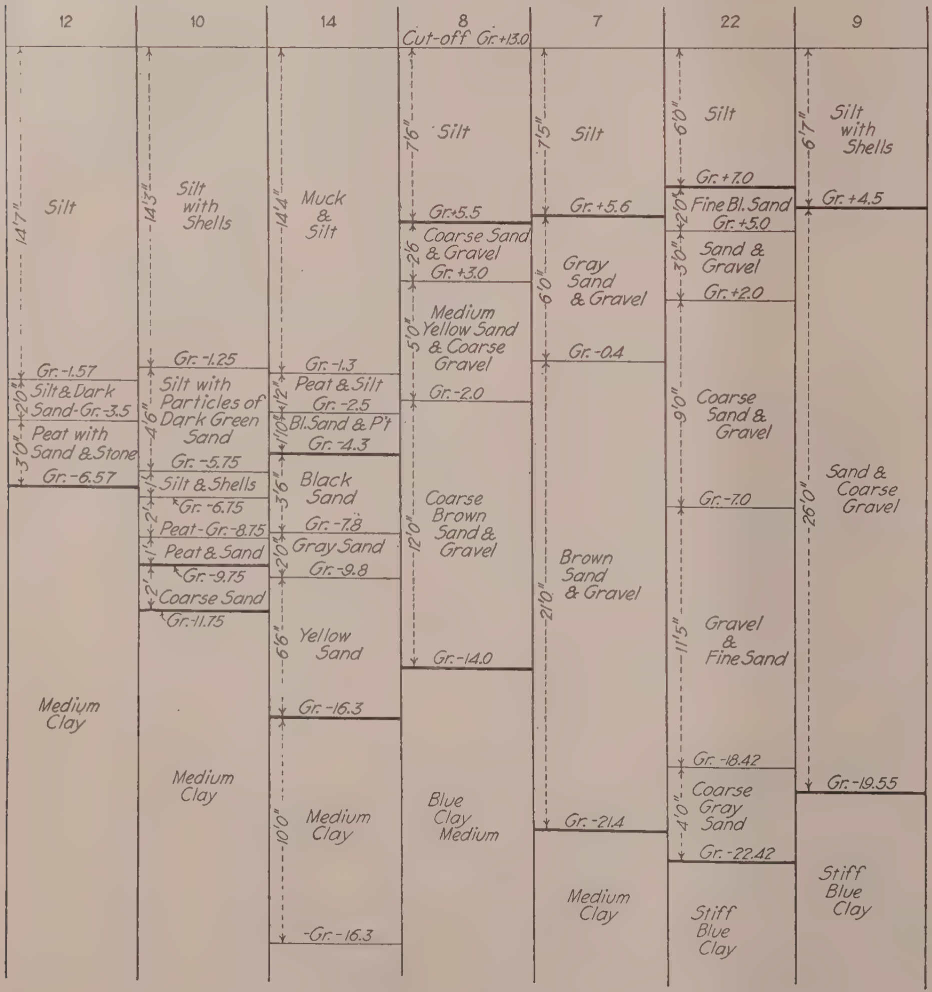
Spruce pile 3, 17 ft. long, with a diameter of 9 in. at the butt and 6 in. at the tip, was driven with a 2300-lb. hammer under short drops until the last few blows. Then an average drop of 9 ft. 8 in. was given and a value of 16.7 tons obtained when using the so-called *Engineering News* formula:

$$P = 2\,Wh/(S+1)$$

in which P is supporting power in pounds; W is weight of hammer in pounds; h is fall of hammer in feet, and S is penetration in inches. This pile passed through about 10 ft. 6 in. of loose sand, silt, shells and blue-black mud and penetrated into coarse sand and gravel about 3 ft. 9 in. When pulled after load testing it was found broken at about the surface of the gravel and badly broomed at the break. When tested with a load this pile caried 5.5 tons without noticeable settlement. When this load was doubled, however, it settled ¼ in. As would be expected, the increments of settlement after this were marked, and under a load of 48,674 lb. run from 19/32 to 1 in.


Building Load 32000# per Linear Ft.
Cutoff Gr.+13.0
Fill
Weight 850# per Sq.Ft.
Gr.+4.50
Coarse Yellow Sand & Gravel
Weight 1440# per Sq.Ft.
Bottom Pile Gr.-0.5
Assumed Angle of Pressure
60°
Gr.-7.5
Load on Clay Due to Soil Above = 2290# per Sq.Ft.
Building Load on Clay = 1530# per Sq.Ft
Total Load on Clay = 3820# per Sq.Ft

ASSUMED DISTRIBUTION OF LOAD ON CLAY



SECTION THROUGH TESTBORINGS, SHOWING TYPICAL SOIL VARIATIONS

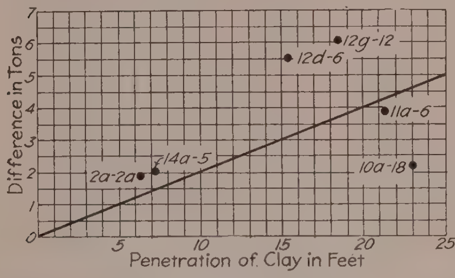
Spruce pile 5, with a diameter of 11 in. at the butt and a 6 in. tip, was driven likewise with a 2300-lb. hammer. With an average hammer drop of 6 ft. 2 in. in the last few blows, this showed an average settlement of ⅝ in. per blow, giving a formula value of 8.77 tons. This pile passed through about 9 ft. 7 in. of loose sand, silt, shells, silt and black mud, and penetrated the coarse sand and gravel about 5 ft. 1 in. When pulled, it was found broomed and broken just below the top of the gravel. When tested with the load this pile carried 6.8 tons, with a total settlement of only 1/32 in., but it settled quite rapidly for increasing loads. Under 18 tons load the settlement was 7/16 in. and the pile showed a marked tendency to get out of plumb. Under about 20 tons the total settlement amounted to more than 1 in. This pile showed great unreliability.

Spruce pile 7, 18 ft. 4 in. long, had a diameter of 10 in. at the butt and a 6 in. tip. It was driven with a 2300-lb. hammer having an average drop at the last blows of 10 ft. and an average settlement of 1¾ in. This gives a carrying value of 8.4 tons. This pile passed through 9 ft. 2 in. of loose sand, gravel, shells and mud fill, and penetrated the glacial gravel deposit about 5 ft. 9 in. When pulled, it was found broken and broomed just below the top of the gravel. When tested with a load, this pile settled 1/16 in. with 3 tons. The rate of settlement was quite rapid under succeeding increments, amounting to over 1 in. with 15 tons; over 2 in. with 26.5 tons; over 3 in. with 32.75 tons. After the load was removed, it recovered ½ in. of its settlement, showing the effect of the brooming. The typical photographs herewith show the effects noted.

It was plainly evident that spruce piles could not be driven with safety into the harder portions of this glacial deposit. After a study of the results obtained by a number of spruce piles which had been driven and pulled, it was thought best to limit the use of spruce to those places where friction was largely depended upon to give the bearing value, and very little dependence placed on point bearing. The test piles also showed that spruce piles, after driving, might appear good to the piling foreman and the inspector, and yet be found broomed and broken when pulled. This discouraged the use of spruce piles where sudden changes in the hardness of the soil were found or expected. Some of the marked and unaccountable settlements of structures noted from time to time may have been due to some extent to the practice of driving spruce piles into hard crusts, with resultant brooming.

GOOD RESULTS WITH OAK PILES

The tests also proved that first-class oak piles could be driven without injury into well compacted coarse sand or fine gravel to a resistance giving a bearing value of 18 tons or more. Oak piles were used where the driving was hard, and where the supporting value of the pile was to be gained largely from point bearing and relatively small embedment in the hard stratum. For safety a maximum limit of 14 tons was permitted for oak piles; 10 tons was allowed for spruce, where these could be used.



EXCESS OF TEST VALUES FOR PILE IN CLAY ABOVE FORMULA VALUE

From the driving records and boring sections the surface of the glacial deposit appears very uneven in places. Piles driven within a few feet of each other found bottom at levels differing by 10 to 15 ft. or even more. These conditions naturally made it difficult to get uniform pile formula values, and increased the cost of the pile driving.

EFFECT OF HARD FILL

The fill over the original mud flats consisted of mud, silt, shells and gravel. In some places this was very compact and offered considerable resistance to the piles. The friction of this material frequently entered into the final readings, and had a tendency to raise the value above its proper figure. Where a hard fill of gravel or shells was found over glacial gravel, with an intervening layer of peat, silt or mud, it was necessary to drive piles well into the glacial gravel to get their true value.

Not only will the hard fill above the peat and other material give the piles driven through it a high formula value at the time of driving, but it may afterward actually add to the real loads on the piles by reason of its friction when the peat or mud stratum becomes reduced in thickness through decay or displacement.

The varying conditions found have made it necessary to design the pile foundations on a basis of as nearly as possible uniform settlement. This uniformity is highly desirable to prevent overstress of the more or less continuous concrete floorbeams and slabs used in the superstructure of the buildings.

TABLE OF TEST RESULTS FOR PILES EMBEDDED IN CLAY

Pile No.	Length	Embedment		Surface Grades		Weight of Hammer, Lb.	Av. Drop, Ft.	Ave. Pen. Last 3 Blows, In.	Formula Load, Tons	Test Load at 1-16 in. Settlement, Tons	Factor of Safety at ¼ in. Settlement	Allowable Value for F. S. of 2.5 Tons
		Sand	Clay	Sand	Clay							
14a5	35′ 10″	11′ 6″	7′ 3″	—1.5	—13.0	2,600	10	3¾	5.50	5.5	6.5	7.5
12d6	42′ 6″	11′ 6″	15′ 4″	—1.5	—13.0	2,600	10	3	6.50	9.0	4.0+	12.0
2a2a	35′ 9″	12′ 6″	6′ 2″	—1.5	—14.5	2,150	10	2	7.16	10.0	2.3	9.0+
12g12	45′ 0″	1′ 5″	18′ 4″	....	.....	2,600	10	3⅝	5.90	15.43	2.0	12.0
11a6	50′ 0″	0′ 0″	21′ 3″	0	—13.2	2,580	10	4¾	4.50	12.80	1.63	8.4
10a18	42′ 6″	0′ 0″	23′ 0″	0	—6.6	2,300	10	3	5.80	12.80	1.60	8.2

The working values have been taken at about 1/16 in. settlement as shown by the tests. It is believed that most piles have an initial settlement, whether noted or not, and considerable care was taken to note settlement at all times where the change was as large as 1/64 in. It is also believed that the effect of the difference in settlement of 1/16 in. in the foundations can be easily ignored. A settlement of ¼ in. was considered to be the limit of usefulness of the pile. It was assumed that settlements greater than this create conditions which might cause very unsatisfactory results. It was also considered necessary that the piling have a safety factor of not less than 2.5 on the tonnage based on ¼ in. settlement.

From the results of the test piles it is evident that in the majority of cases the piles had to be driven quite deeply into the sand to assure a satisfactory value. An effort was made to keep the piles in the glacial sand, even where it thinned up, for it was desirable to use the sand stratum as a medium for spreading the loads out over the clay under it. An effort was made to have a minimum of at least 3 ft. of sand under the points, even where the sand thinned up, in order to make the spreading of the load somewhat effective. But it was found that there were places where the sand was very thin, giving little value to the piles. To ascertain the value of the clay under working and ultimate loads, some piles driven both partly and wholly into the clay were load tested. Two of these were also re-driven, as were a number of others. The results showed in many cases a formula value over twice as great as the value obtained when originally driven.

SAFE WORKING VALUES

Regarding the safe working values, the tests showed that for the assumed limits of settlement and safety factor, piles driven into sand could be used at their formula value, but not much higher. On the other hand, piles embedded in the clay found at this site showed an ability to carry test loads in excess of the formula value, as indicated on the figure herewith, and in the table. The curve shown in the diagram indicates that the allowable increase on the formula value appears to be about 1 ton for every 5 ft. of embedment in the clay.

Full advantage was taken of this fact where the gravel and sand became either unreliable or of no practical value, or where they disappeared. Piers were frequently made in clay in which the average formula value for the piles was 6 tons or less, but owing to the high value shown by tests these were allowed a value fully 50 per cent greater, provided it was evident that the piles were well embedded in the clay.

Three piles showed a high tonnage at 1/16 in. settlement which, when compared with the tonnage at ¼ in. settlement, gave a low factor of safety. But when the allowable value was reduced to get a factor of about 2.5, there was still a very substantial amount above the formula tonnage found at the time of driving. It is interesting to note that the formula tonnage found by re-driving the piles, after they had been allowed to set thoroughly, did not represent either the value under test load at 1/16 in. settlement, or the allowable tonnage.

DESIGN TO PREVENT VIBRATION

Another feature in the problem of these foundations is the matter of vibration due to internal and external forces. It was, of course, necessary to construct the foundations in such a way as to reduce the possibility of vibration to a minimum. This was not only for comfort, but because some of the laboratories will contain instruments of special accuracy and delicacy. Special care has been taken with the foundations under heavy testing machinery, to reduce the possibility of settlement and excessive vibration. A sufficient number of well-driven piles is placed under such machines, each being allowed about one-half of the value given to the piles under the building walls.

The greatest vibration will come to the structures from external sources, such as

BROOMED AND BROKEN TIPS OF SPRUCE PILES

engines in nearby power houses, from trains, electric cars, etc. These vibrations will be conveyed to the buildings by the comparatively hard top fill which lies over the stratum of mud, silt and peat. Peat is found in some locations within the building site. It is probably general on the north and east sides of the buildings, extending through that portion of East Cambridge where a number of factories and power houses are located. Nearly the entire site of the new buildings has a stratum of silt, mud and fill above the sand and clay. The buildings have, therefore, for their entire lengths above that part embedded in sand or clay, a foundation of piles which pass through a material affording very little lateral support.

Under the action of driving the piles this material softened to such an extent that it allowed the piles to vibrate strongly, even throwing mud and water out around them. Structures which are supported on piles passing through such soft water-filled strata not only readily send out vibrations, but are strongly affected by vibrations from other sources situated along the same strata.

One method of resisting in part such a tendency is to drive the piles well into the supporting strata, rather than resting them on the surface or with a foot or two only of penetration. As the pile tests show that it was necessary, generally, to get a fair embedment in order to obtain the bearing values desired, it was unnecessary to make a large increase in that embedment in order to gain stiffness.

In general, the allowable loads per pile average 9.5 tons for interior piers and 8.75 to 9 tons for exterior piers and walls. It is believed that if settlements occur the small difference in loading will tend to make slightly greater settlements in the center of the building. This will prevent the bulging tendency of the walls, which would occur if the wall piles settled more than the interior piles.

Foundations Above Piles

Reinforced-concrete spread footings were used to distribute the wall and column loads to the piles. Such footings are permissible only when placed on a compressible surface of practically uniform resistance. This will produce bending stresses in the footings similar to those produced by a uniformly distributed load.

The permanent ground water level permitted the cut-off grade of piles to be fixed at 13 ft. above the Cambridge datum, which is 4.1 ft. below the basement floor level. With few exceptions, this difference of 4.1 ft. between the floor and the pile cut-off permitted the reinforced spread footings to be placed without lowering the cut-off. The design of these footings was based on the formulas recommended by Prof. Arthur N. Talbot of the University of Illinois, in Bulletin 67, as determined from the result of many experiments.

This work of pile testing and design was conducted by the writers as consulting engineers for the contractors, the Stone & Webster Engineering Corporation.

For Solidification of Railroad Fills

H. C. Phillips, valuation engineer of the Santa Fé system, speaking for the railroads at the recent valuation conference, stated that he would allow an increase in value of 2 per cent per year for five years and 1½ per cent thereafter until the total enhancement reached 25 per cent.

Letters to the Editor

Comment on matters of interest to engineers and contractors will be welcomed

Waterworks Summary Should Show 24 Plants in Porto Rico

SIR: I note on page 13 of the Engineering Record for July 3, in the statistical summary of American waterworks, that Porto Rico is credited with seven towns as having waterworks. This figure should be 24, as there were nine on the Island when I went there in 1911, and there were constructed during my three years' stay fifteen waterworks, which I designed and of which I supervised the construction. It is possible that there are now even more, for when I left in 1914 I had prepared plans for nineteen other towns, on some of which, at least, it was hoped to start construction at an early date.

RICHARD M. MERRIMAN,
Central Valley, N. Y. Civil Engineer.

Experiments on Separate Digestion of Activated Sludge Needed

SIR: The several large scale experiments on treatment of sewage by means of aeration and contact with activated sludge, being conducted in America as a result of the success of the smaller scale investigations begun in England, have aroused interest and hopes that from them may possibly be evolved a more economical method of treating the sewage of large communities than by tanks and percolating filters. The data so far published indicate the possibility of producing by the activated sludge process a clear, bright, well oxidized effluent and a high percentage removal of bacteria. It further appears that the resultant sludge is of high percentage moisture, but readily separates therefrom.

The investigations of Ardern, Lockett, and Duckworth in England show that the complete process may be divided into two parts: First, clarification and removal of putrescence; and, second, nitrification and maintenance of the sludge in an activated state. In the disposal of the sewage of large cities generally, only clarification is needed at the present time, but provision should be made in the design of works so that, with increasing population and raised standards of cleanliness required for water courses, the treatment could be increased to include oxidation. The activated sludge process seems to be particularly adapted to meet this condition, for but short periods of aeration in contact with activated sludge effect a practically complete removal of suspended and colloidal matters. The difficulty at present seems to be that unless aeration is continued until the sewage is well oxidized the sludge loses its activity.

Ardern has suggested that economy may be obtained by aeration of sewage in contact with activated sludge only to the point of clarification and aeration of the sludge without sewage to maintain its activity. The writer feels that experimenters have neglected this possibility on account of the apparent ease in carrying on aeration to the point of high nitrification. A town on the bank of a river suitable for disposal of sewage by dilution wastes its public funds in completely oxidizing artificially at considerable expense what the stream is able to do naturally at no expense.

The high percentage moisture in the sludge and the complete removal of suspended matter indicate a large volume of wet sludge per million gallons of sewage treated and, further, it is reported that while, as first withdrawn, the sludge is inodorous, if kept for a few days putrefaction sets in.

It would therefore appear that experimentation on the separate digestion of the activated sludge would be desirable in order to obtain a sludge of less bulk and free from odor as obtained at Baltimore, Md., and Birmingham, England.

W. L. STEVENSON,
Assistant Engineer, Bureau of Surveys,
Philadelphia.

Engineers for Public Boards and Commissions

SIR: Cognizant of the fact that boards and commissions in the service of the State of Massachusetts whose duties are chiefly civil engineering are and have been made up of men who have had no civil engineering training and experience, a concerted effort is to be made by civil engineers and others to see to it that the Governor shall be impressed with the great need for proper technical representation upon such bodies.

Too long persons whose qualifications have been chiefly political, social or otherwise have been appointed to positions on important boards and commissions of this commonwealth, where civil engineering knowledge and experience should have been essential requisites.

It is not to be presumed, however desirable it may be, that such public bodies shall be made up entirely of men possessing the aforementioned qualifications; but the present tendency toward economy and increased efficiency in public affairs demands, if advance is to be made along these lines, that bodies of the public service under consideration here, shall have among their memberships at least some one who shall possess among others the desired qualifications, viz., civil engineering knowledge and experience. It cannot be denied that this is highly desirable and necessary in the light of facts well known to civil engineers, and often all too evident.

CHAS. C. CARROLL.
Secretary, Public Service Civil Engineers' Association of Massachusetts.
Boston, Mass.

[This journal has repeatedly urged the desirability of engineer-members of public bodies having control of engineering works. It has endorsed heartily the efforts of engineers of New York State to impress this view on the constitutional convention now in session at Albany. To make its appeal to the Governor most effective the association sending the communication printed above should enlist the co-operation of all other societies of engineers in Massachusetts.—EDITOR.]

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents

[*Contributions to this section are solicited, and if found available will be paid for. They must be* SHORT, *and should be accompanied, if possible, by photographs or sketches.*—EDITOR.]

Tool for Reboring Cylinders Run by Air Boring Machine

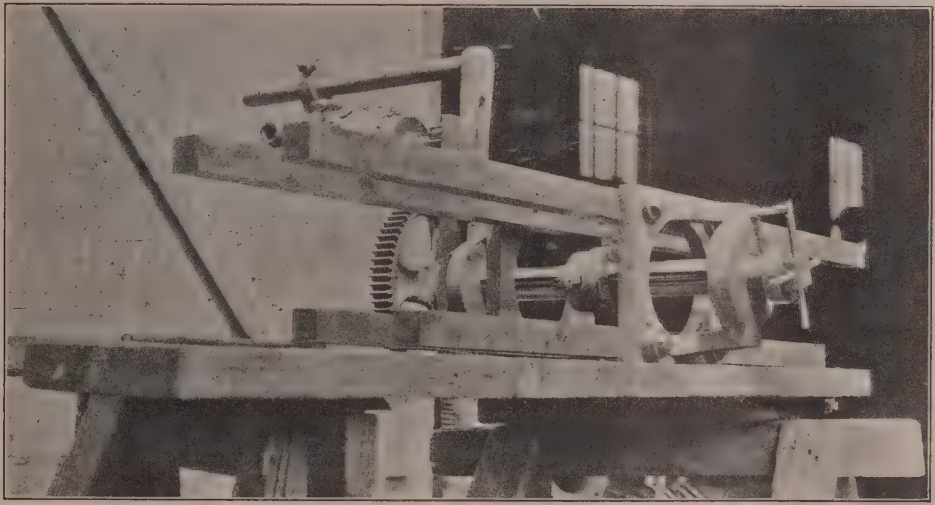
By WALTER BAZORE

Master Mechanic, Rapid Transit Subway Construction Company, New York City

AN AIR BORING machine is shown in the accompanying photograph geared to a small lathe used for reboring cylinders. The cutter head of the lathe, which is shown in the center, is mounted with a sliding fit on the main shaft. Through it passes the feed screw, which lies in the slot shown in the side of the shaft. At the right side of the machine is seen a bolt projecting from the top of the frame. At each revolution, as the head of the feed screw, which is, of course, eccentric with the shaft, comes on top, one of the arms projecting from the head strikes this bolt and gives the screw one-eighth turn before it is released and slips past the bolt. The shaft is driven through three gears by the air motor, which is shown at the left, on top. The spindle of the first gear in the series fits into the chuck of the air machine.

The machine is shown assembled with four long bars of chrome steel, with very carefully machined plane surfaces. These are used in attaching the machine to its job, where that method is more convenient than dismounting the part to be rebored and taking it to the machine shop. The tool was used recently to rebore a 6-in. diameter hole 7 in. long for one crank pin of a 5000-ft. air compressor. After the machine was set in position, the hole was rebored exactly true at one operation, which took eighteen minutes.

This machine was made from spare machine parts without a great deal of labor, for reboring worn cylinders of hoisting engines, etc., right on the job. It was built by the writer, and is used in the machine shop of the Rapid Transit Subway Construction Company's power plant at Forty-second Street and East River, New York City.



HOME-MADE LATHE DOES ACCURATE REBORING ON THE JOB

Rock Drills Must Be Well Maintained to Secure Efficiency

THAT CLOSER attention to renewing worn parts in rock drills and to making properly shaped shanks on the steels used results in an increase of power efficiency and in eliminating delays due to broken drills was well brought out by George T. Cousins in addressing a recent meeting of the National Lime Manufacturers' Association. The parts of the ordinary reciprocating drills which wear most quickly are the cylinder, piston and rod, and the front head, or, in drills that have them, the front head bushing. The front head is mainly depended on to keep the piston true in the cylinder. The side thrust of the piston rod, combined with particles of rock dust adhering to the rod, wears the front head after a time so that the piston is no longer held true. The result is rapid wear of the cylinder. Bushings and front heads are less expensive than cylinders, and should be renewed as soon as they begin to wear. Rough piston rods are a frequent cause of leaky packing, and care should be exercised to keep them smooth. Valves should be kept tight, as a drill will not do good work if air is flowing through all ports at the same time. A little wear on the valve will have a surprising effect in the operation of the drill.

Neglect in oiling drills until after the runner has been reminded that they use oil by having the valve stick is not unusual. Carrying oil in open cans and coffee pots with the lids gone results in pouring grit into the machine with the oil and wearing it very rapidly.

The troubles of a hammer drill are somewhat different from those of a piston drill. The feature that causes the most trouble is bad shaping of the shank of the drill steel. Using steels with broken shanks very quickly results in a broken anvil block. The end of the shank must be made smooth and true, and the larger the end, the better. Sometimes the ends are beveled around the edge until a face the size of a dime is all that is left for the piston to strike. The result is that a cup soon wears in the piston or anvil block, and a break results. If the shanks are carelessly hardened, they are apt to break in the drill and cause trouble. Even if the ends of the shanks are ground on an emery wheel, they should be tried with a square to make sure that they are true.

Broken steels and anvil blocks are sometimes caused in this type of drill by a worn front-head bushing or a worn rotating sleeve. This sleeve wears large, and allows the steel to tilt in the hammer, so that the anvil block does not strike it a square blow.

If the rotation parts of a hammer drill are worn, and back-lash exists, the rotation does not start to turn when the piston begins to move, but all of the back-lash is taken up with a snap near the middle of the stroke when the piston is moving fast. This is very hard on the rotation parts. Frequent oiling is essential with the hammer drill if good results are to be expected.

Steam Shovel Cuts Costs of Repairing Sub-Grade on Paving Contract

By ALBERT D. BLAKESLEE

Superintendent for C. W. Blakeslee & Sons, General Contractors, New Haven, Conn.

DURING the season of 1914 C. W. Blakeslee & Sons had about $500,000 worth of street paving to do for the city of New Haven, and the Connecticut Company, which operates the trolley lines in New Haven. A large part of this was wood block, some sheet asphalt, and on secondary or light traffic streets we laid bituminous macadam. In preparing the sub-grade for wood blocks we had to remove 10½ in. and for asphalt 9 in. of old macadam on a telford base.

At the beginning of the season we broke up the pavement with a 10-ton road roller, using picks in the wheels and pulling a rooter plow. It took all of the roller's time to do this, and three men to hold the plow.

After a short while we had a model 31 revolving Marion steam shovel idle so we decided to try using it. The boom was too high to go under the trolley span wires, so we spliced the hog rods about 4 ft. with some heavy chain, lowering the boom enough to clear wires. We excavated one side of a street at a time loading the teams on the old pavement on the first cut and loading on the new finished pavement on the second.

The following lists of men, teams and equipment give an idea of the saving:

COSTS OF PREPARING SUB-GRADE WITH ROLLER AND PLOW AND WITH STEAM SHOVEL

Old Method	*New Method*
1 10-ton roller (1 engineer)	1 model 31 revolving steam shovel (1 engineer, 1 fireman)
1 rooter plow (3 laborers)	1 foreman
2 foremen	6 laborers or pit men
30 laborers	9 to 11 teams
1 mold-board plow—1 double plow team (this team also did the towing out)	
13 to 15 double teams	

The difference in the number of teams is accounted for by the fact that only one team is standing loading at a time, and it only takes 2 min. to load instead of 10 to 15 min. Also there is no plow or tow team needed. Needless to say Blakeslee & Sons would not tackle a job of this kind again without a shovel.

Explosives Loosen Hard Ground for Driving Concrete Piles

BY THE USE OF explosives to break up hard ground concrete piles have been driven in the Philippines where other conditions called for a pile bridge, but where the ground would not ordinarily allow piles to be driven. Frank P. James, writing in the *Quarterly Bulletin* of the Bureau of Public Works of the Islands, tells how he employed this method on the Cabugao Bridge, Ilocos Fur.

The strata encountered included gravel compacted with sand and clay and carrying boulders up to 10 in. in diameter. From experiments on another bridge, where black powder had been used to loosen stiff clay for the same purpose, it had been determined that the ground was broken up about down to the bottom of the charge placed to make way for the piles. As nearly 20-ft. penetration was required on the piles on the Cabugao bridge, the explosive cartridges used were placed so that their lower ends were about 19 ft. below surface. There were five piles in a bent, and three shots were necessary for each bent, one each at the location of the two end and the center piles.

METHOD OF CHARGING GROUND

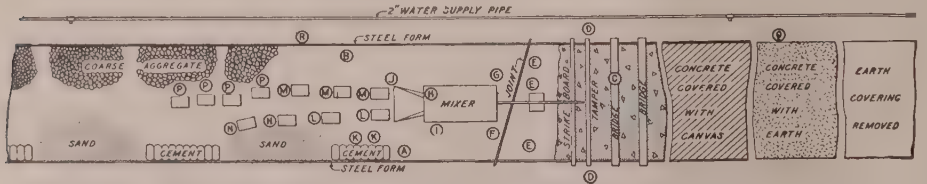
The charges were placed by driving down a 3-in. diameter galvanized length of pipe about 20 ft. long. A coupling was placed on the driving end of the pipe, and the lower end was fitted with a cap which remained in the ground. One cap was required for each hole. These caps were made of pieces of old steel plate ½ in. thick and 7 in. square. The plates were notched deeply on their four sides, and the corners thus left bent up to fit around the end of the pipe. A hole was punched in the center of each plate through which a 2-in. piece of ¾-in. round steel was driven, while the plate was hot, to form a point and guide the pipe in driving. The charge for each shot was loaded in a 2½-in. diameter tin tube about 39 in. long, in the bottom of which was tamped about 28 in. of powder. Above this were loaded two exploder sticks of dynamite, which was required to set off the type of powder used, and around these sticks was packed the contents of a third broken stick. Each of the exploder sticks had a cap and fuse of its own, to insure detonation. Above these were put more powder and a wad of thin paper such as is used to wrap rolls of fuse. The whole was sealed with asphalt or white lead, and the end of the tube was crimped slightly.

When the 3-in. pipe had been driven to the required grade, the charge was dropped to the bottom of it, and a 1-in. pipe was lowered around two fuses. The 3-in. pipe was then pulled about 6 ft. by a rope running to the engine of the driver, allowing dirt to run in around the cartridge. The 1-in. pipe was then withdrawn, and the 3-in. pipe pulled all the way out. One of the fuses was cut about a foot longer than the other to insure safety in lighting, which was done with a torch.

After the three holes for each bent were fired, the concrete piles were driven. Very satisfactory results as to grade were obtained, a few inches remaining below the disturbed ground in every case after the shot into which the tip of the pile could be driven. The bearing power developed exceeded the requirements.

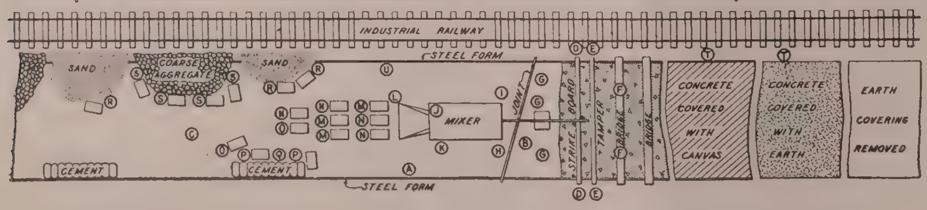
How Do You Man Your Paving Mixer?

ORGANIZING a force of laborers to operate a paving mixer efficiently requires considerable skill. The accompanying diagrams, which are taken from Bulletin 249 of the United States Department of Agriculture, written by C. H. Moorefield and James T. Voshell of the U. S. Office of Public Roads, were worked out by a contractor with wide experience in concrete road construction. The mixer in both cases is fully manned, and each laborer has definite work to perform. The diagrams cover only the men engaged in mixing and placing the concrete. Labor for preparing the sub-grade, setting forms, and covering the concrete with earth should be provided in addition. Once started, the operation of concreting should be as continuous as the weather will permit, if low costs are to be maintained.



DISTRIBUTION OF FORCE ON CONCRETE ROAD WORK, USING TWO-BAG MIXER

A, foreman; B, subforeman; C, finisher; D, 2 laborers striking and tamping; E, 3 laborers placing concrete and assisting in striking; F, mixer tender; G, laborer cleaning subgrade and setting joints; H, mixer engineer; I, fireman, also sprinkles subgrade; J, laborer assisting wheelers and cement handlers; K, 2 laborers handling cement; L, 2 laborers wheeling sand; M, 3 laborers wheeling coarse aggregate; N, 2 laborers loading sand; P, 4 laborers loading coarse aggregate; Q, laborer sprinkling pavement; R, water boy. Total, 2 foremen and 25 laborers. ☐ indicates wheelbarrow.



DISTRIBUTION OF FORCE ON CONCRETE ROAD WORK, USING THREE-BAG MIXER

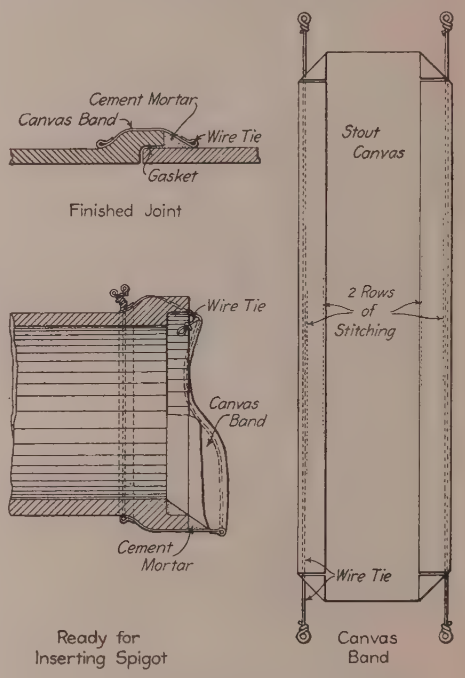
A, foreman; B, subforeman on placing concrete; C, subforeman on charging mixer; D, 2 laborers striking; E, 2 laborers tamping; F, 2 finishers; G, 3 laborers placing concrete; H, mixer tender; I, laborer cleaning subgrade and setting joints; J, mixer engineer; K, fireman, also sprinkles subgrade; L, laborer assisting wheelers; M, 3 laborers wheeling sand; N, 4 laborers wheeling coarse aggregate; O, 2 laborers wheeling cement; P, 2 laborers handling cement; Q, laborer opening bags; R, 3 laborers loading sand; S, 4 laborers loading coarse aggregate; T, 2 laborers sprinkling pavement; U, water boy. Total, 3 foremen and 36 laborers. ☐ indicates wheelbarrow.

Mortar Joint Laid with Canvas Band in Wet Trench

By D. H. FLEMING

Assistant City Engineer, St. Catharines, Ontario

THE CANVAS band and the method of using it shown in the accompanying drawing have enabled good cement-mortar joints to be made in sewer pipe laid in wet trenches. The stout canvas band is a few inches longer than the circumference of the bell of the pipe, and is of sufficient width to completely envelop the bell and its mortar joint. A small pliable wire is inserted between the double stitching along each edge, and is looped at each end to avoid its coming out. The band is fastened around the bell of the last pipe laid by twisting up one of these wires. This is done with each section of pipe before lowering it into the trench. The joint is made in the usual manner with the gasket and cement-mortar, the lower half of the canvas band being filled with mortar as well as the invert of the bell. After the spigot end of the next length of pipe is in place, the second wire tie is fastened around it. This draws the band up tight around the joint, and prevents water in the trench from washing the cement out of the mortar joint.



CANVAS BAND PROTECTS CEMENT JOINT

The joint protector is not withdrawn, but remains as a permanent part of the construction. It was devised and used with great success by E. R. Gray, at the time he was district engineer in the sewer section of the Department of Works, Toronto, Ont. Mr. Gray is now chief assistant city engineer of Hamilton, Ont.

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

Attempt to Modify Contracts After Awards Are Made

Court Order Results from Action of New York City's Board of Estimate in Striking Out Clause When Contract Is Approved

By approving several subway contracts with the omission of a clause providing for an adjustment between the Public Service Commission and the contractor of the payment for extra work ordered, the Board of Estimate of New York City has become involved in a law suit which, it is said, may delay the completion of the New York municipal lines in Manhattan. The form of contract, the same as that in force on all work on New York's subways for over two years, had been approved by the Corporation Counsel, officially representing the Board, as required by law, before bids for this work were advertised. The work was let, and the contracts awarded and sent to the Board for final approval by the Public Service Commission.

The Corporation Counsel is quoted in the press as holding that the omission made by the Board of Estimate is equivalent to a rejection of the contracts, as the Board lacks authority to modify them after bids have been received and awards made. One of the contractors affected, the Holbrook, Cabot & Rollins Corporation, has refused to accept its contract, holding that it is now void. They have secured from Justice Delehanty of the New York Supreme Court an order to the Board of Estimate to show cause why the Court should not issue a writ of mandamus compelling the Board to expunge from its record its action taken in striking the extra work clause from the contract. Such a writ, if issued, would cause the contract to stand approved in its original form, and would make an easy way out of the tangle.

Express Track "Humps" in Operation on Ninth Avenue, New York

The Ninth Avenue express trains in New York City were put into operation over the new "hump" construction at stations for the first time on Monday, Aug. 16. This is the first operation over any of the Manhattan elevated improvement work. On this line a center express track had been in operation before the improvement, but new upper-level platforms reached by the general type of hump construction described in the Engineering Record of July 31, page 138, had to be constructed at the Fourteenth Street, Thirty-fourth Street, and Sixty-sixth Street stations.

These station platforms are not completed, but the steelwork for the center track has been erected and, in addition, the grade crossing at Fifty-third Street has been eliminated. Two weeks only were required for this work, express train operation being suspended between Aug. 2 and Aug. 16. The work was done by Terry & Tench and Snare & Triest, contractors, associated with the T. A. Gillespie Company, executives.

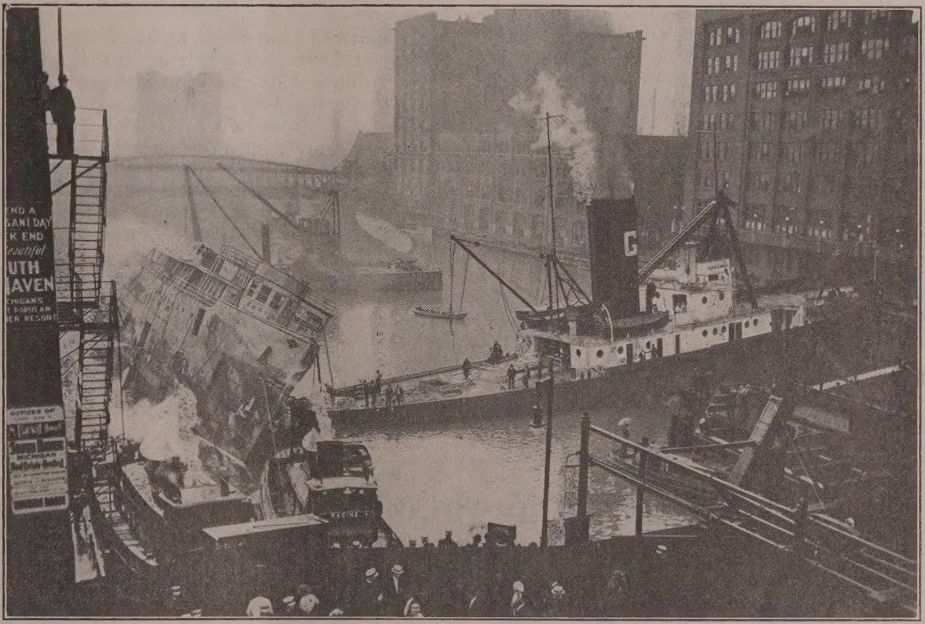
Start Work on Big Oil Storage Reservoir in California

Work has been started on the oil storage reservoir of the General Petroleum Company near Port Arthur, Cal., which, it is said, will be the largest reservoir of its kind in Southern California. It will have a capacity of 500,000,000 barrels and will be used for export storage. Its roof, which will be of redwood, will cover 3½ acres. The reservoir will be concrete lined.

"Eastland" Righted by Cables and Water Displacement

On Aug. 14, three weeks after toppling over in the Chicago River, the Eastland was raised to an approximately upright position by the Dunham Towing & Wrecking Company of Chicago. Shifting of coal in the bow to the port side and the influx of water from holes that had been imperfectly covered caused considerable delay.

Two cables were used in raising the boat. One was attached to the iron standard streak on the starboard side of the steamer and then run around the boat and attached to the stern of the Dunham Company's tug "Favorite." The other cable was attached to the "chop" at the other end of the boat, and run around and made fast to a pontoon. Both the "Favorite" and the pontoon were filled with water until the former was dropped down to a depth of 8½ ft. and the latter to a depth of 9 ft.



TUG AND PONTOON RIGHTING THE ILL-FATED EASTLAND IN CHICAGO RIVER

The cables being attached as described, rotary centrifugal pumps were set at work pumping water out of the tug and the pontoon. As the two rose the Eastland was slowly raised and, after four hours, floated once more. A good share of the three weeks' time was spent in sealing the openings under water so that the water could be pumped out of the boat itself.

Los Angeles Aqueduct Water Goes to Hollywood District

The Board of Public Commissioners of Los Angeles, with the approval of the Railroad Commission of California, ratified, Aug. 6, a contract between the city of Los Angeles and the Union Hollywood Water Company, which authorizes taking over and operating by lease that portion of the Hollywood Company's water mains outside the limits of the latter city. The mains lying within the city boundaries were taken over by Los Angeles some time ago. The total cost of the system in and outside the Hollywood limits is $568,408 with interest at 6 per cent from June 1. The rental on the proposed lease basis is to apply on the purchase price, pending an election on a contemplated $1,000,000 bond issue to be held in the district.

Galveston Storm-Swept

Damage May Exceed That of 1900—Conflicting Reports Received as to Condition of City's Sea-Wall and Causeway

The extent of the damage to engineering structures by the Galveston storm this week is more or less a matter of conjecture, for telegraphic communication has been so completely demoralized that no replies to this journal's despatches were received before going to press. The structures of Galveston of principal interest to engineers are the sea-wall and the causeway which connects the island upon which the city is located with the mainland. Reports state that both of these works have been damaged. One story, which it has not been possible to confirm, says that about 1000 ft. of the sea-wall has been washed out and that a section near the middle of the causeway has been demolished. On the other hand, the Concrete-Steel Engineering Company of New York, which designed the causeway, has informed this journal that reliable information has been received to the effect that the causeway is intact with the exception that portions of the earth-fill approaches have been damaged by the storm. It is claimed also that the draw-span near the center of the structure has not been destroyed. Some of the despatches report great damage to the city's water supply system.

The U. S. Weather Bureau has received from Houston a special report stating that the storm center passed south of that city about 5.30 a. m., Aug. 17, with the lowest barometer at Houston 28.21 in. and a wind velocity of 80 miles per hour and rainfall 7.18 in. in the preceding 24 hours.

Columbia River Highway Dedicated

The newly completed Columbia River highway from Portland to Gearhart, Ore., a distance of 125 miles, was officially christened Aug. 12. Forty automobiles traveled the distance in less than seven hours' running time. Many of the municipalities declared a holiday and, at Gearhart, the fastivities continued far into the night. This road affords the city of Portland an easy overland route to the ocean and opens up wide tracts of land to settlement.

Seattle Completes Municipal Grain Elevator

A 500,000-bu. bulk grain elevator built, owned and operated by the municipality has just been completed and has received its first consignment of grain at Seattle, Wash. Its function is to provide storage for the local flouring mills, and to facilitate the interchange between rail and ship transportation in handling the product of the grain fields of Montana, Idaho and Washington.

The structure is entirely of concrete, 165 ft. high, and has a receiving capacity of 95 cars per 24 hr. and a bulk shipping capacity of 20,000 bu. per hour. The equipment is all electrically driven. Four railroads have access to the elevator which stands between the tracks and dock. The costs of the structure were as follows: Foundation, $25,162; superstructure, $197,900; cement, $15,800; bulk shipping galleries and equipment, $31,000; track, $10,000; miscellaneous, $2,000; total, $281,862.

Missouri Pacific System Goes Into Receivership

Benjamin F. Bush, president of the Missouri Pacific and the St. Louis, Iron Mountain & Southern Railways, was appointed receiver, Aug. 17, of the two lines. The immediate causes of the receivership are the inability of the system to meet interest payments of almost $2,000,000 due Sept. 1, and the refusal of some of the security holders to accept the reorganization plan recently announced. The system embraces 7285 miles, and ranks next to the Rock Island system, which went into receivers' hands last April, as the largest railroad system in the country to go into bankruptcy.

California Public Utilities All Go Under Commission Jurisdiction

All privately owned public and quasi-public utilities in California, together with the power for fixing service rates, became, on Aug. 7, subject to the jurisdiction of the railroad commission of that State. The only exceptions to State control are utilities owned and operated by municipalities within municipal limits. The extension by a municipality of public-utility service outside of its boundary limits, however, brings such service within the jurisdiction of the commission.

Differences Over Hetch Hetchy Valley Construction Adjusted

Differences between nature lovers and the city of San Francisco regarding the flooding of Hetch Hetchy valley to facilitate construction of the dam, have been adjusted, it is stated, and the building of the temporary diversion dam which will flood the floor of the valley, is to be commenced at an early date. Over part of the route, the grading for the railroad to the dam site has been completed, and it is hoped that work on the dam can be commenced next summer. A description of the Hetch Hetchy project will be found in the Engineering Record for Feb. 20, 1915, page 226.

Wisconsin Legislature Changes Highway Law

No longer do the State highway officials in Wisconsin have any check on the eligibility of the county highway commissioners. Formerly these men were examined and more than one might be placed on the eligible list from which the county commissioners could make appointments, but the last Legislature has eliminated this feature. By the present law a county road committee is to be appointed by the county commissioners. A member of this committee may or may not be a commissioner. The committee appoints the road commissioner and will handle all road affairs including the purchase of machinery. State-aid work is to be handled under State inspection in much the same way as at present, but appropriations have been cut practically in half. For the engineering work $65,000 annually is available instead of $100,000.

Local Firms Low Bidders on Philadelphia Transit Contracts

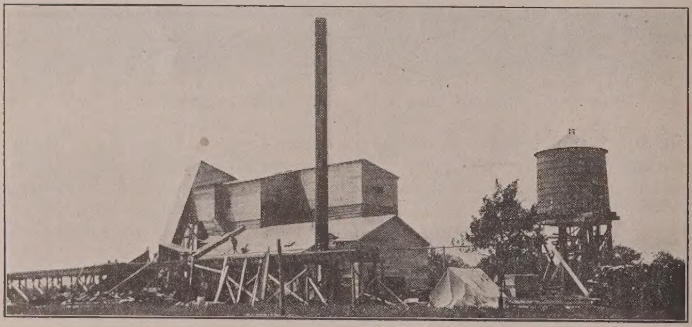
First Earth to Be Turned on Subway Section September 13—First Steps Had Been Taken in May, 1912

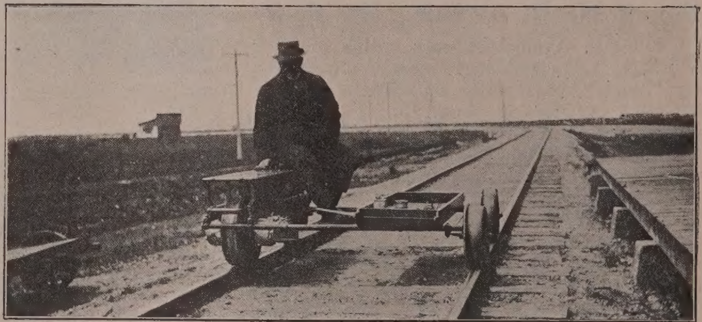
Two Philadelphia firms were low bidders on the first two sections of that city's new rapid transit lines. The bids were opened on Aug. 16 after the Pennsylvania State Public Service Commission had issued a certificate of public convenience permitting the letting to proceed. Citizens of Philadelphia voted $6,000,000 on April 29 last by an overwhelming majority to begin this work. Of this City Council has appropriated $3,000,000 for the first subway section and $3,000,000 for the first elevated section. The low bid of $1,700,000 for the first subway section was, therefore, very gratifying to the city. The other bid of $142,590 was for the construction of foundations for about four miles of the Frankford Elevated line. The subway section on which bids were opened will extend from Filbert Street to Broad Street under the Philadelphia City Hall.

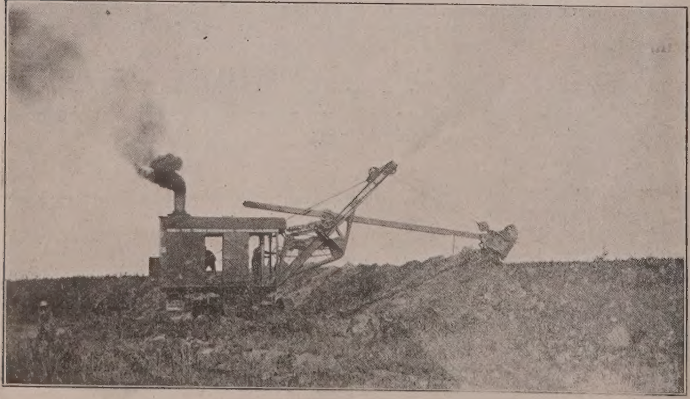
Three Years' Fight for Transit Facilities

The opening of these bids marks the end of more than three years' work on the part of the Department of City Transit of Philadelphia in planning a rapid transit for the city and in educating public opinion to back the project and secure its adoption. In use and under construction New York has 633 miles of rapid transit lines, Chicago has 275 miles and Boston 36 miles, while Philadelphia's present high speed system contains less than 15 miles of track. The present population of Philadelphia is nearly as great as that of Chicago. Philadelphia's transit problem has received a most thorough and careful study under the direction of A. M. Taylor, director of the Department of City Transit. The city was divided into 113 traffic sections, and the flow of traffic from each section to the rest of the city was actually measured by observers of the Commission, and the result, with relation to the population of each district and the present and

Construction Work on Winnipeg's New Aqueduct Is Well Under Way


CONCRETE AGGREGATES WILL BE SCREENED AT CENTRAL PLANT


CONSULTING ENGINEER JAMES H. FUERTES ON AQUEDUCT RAILWAY


SHOVEL STRIPPING LINE AT MILE 43

DRAG-LINE EXCAVATING TRENCH AT MILE 71

proposed transit lines plotted on a large number of maps. The structural features of these rapid transit facilities were designed in the light of experience gained in the large cities of this country and Europe. The two lines proposed for immediate construction, the Broad Street subway and the Frankford Elevated line, will cost together nearly $42,000,000. It is estimated that they will save the traveling public 36,000 hr. per day. The cost of the lines is well within the borrowing power of the city, and it is estimated that while their operation will not be immediately profitable, the indirect benefits to the city, such as the increase in the taxable value of property, will make the investment in these lines a very profitable one.

The entire plan has been vigorously opposed from several quarters. The latest move of the obstructionists was a taxpayer's suit begun to halt the entire project. It is expected, however, that the Public Service Commission's decision of Aug. 14 authorizing the beginning of construction will foredoom this suit's failure in the Courts. On September 13 the first spadefull of earth will be turned on each contract with appropriate ceremonies.

Speakers and Papers for Engineering Congress Announced

The names of the speakers for the International Engineering Congress, to be held at San Francisco, Sept. 20-25, and the subjects of their papers have been made public. The program of the congress is as given on page 150 of the July 31 issue of this journal. Following are some of the speakers and papers of particular interest to civil engineers:

The Panama Canal

Gen. G. W. Goethals, "Introductory Chapter."
Emory R. Johnson, "Commercial and Trade Aspects of the Panama Canal."
Capt. R. E. Woods, U. S. A., "The Working Force of the Panama Canal."
F. C. Boggs, "Purchase of Supplies for the Panama Canal."
Donald F. McDonald, "Outline of Canal Zone Geology."
F. D. Wilson, "Climatology and Hydrology of the Panama Canal."

Waterways

W. H. Bixby, Brigadier General, U. S. A., retired, "The Province of Waterways in Internal Commerce and Development of a Country."
C. S. Riche, Lieutenant Colonel, Corps of Engineers, U. S. A., "Artificial Waterways Which Form Cut-Offs on Marine Routes and Waterways Consisting of Natural Channels and Bodies of Water Linked by Artificial Channels, Constituting Inside Routes."
C. A. Jolles, Chief Engineer, Diector of the Government "Waterstaat," Netherlands, "The Waterway from the Rhine Through the Netherlands to the North Sea Along the Rivers Rhine, Waal and Nieuwe Maas."
William W. Harts, Lieutenant Colonel, Corps of Engineers, U. S. A., "Natural Waterways in the United States."
H. M. Chittenden, Brigadier General, U. S. A., Retired, "Flood Control."
Charles Davis Jameson, "Flood Control in China."
Dr. Luigi Luiggi, Inspector General of Civil Engineers, Italy, "Works for the Improvement of Navigable Estuaries."
Tadao Okino, Chief Engineer Home Department, Japan, "The River Improvement Works in Japan."
Gen. G. W. Goethals, "Dry Excavation."
W. G. Comber, "Dredging in the Panama Canal."
Brig. Gen. W. L. Sibert, "Construction of Gatun Locks, Dam and Spillway."
S. B. Williamson, "Method of Construction of the Locks, Dams and Regulating Works in the Pacific Division of the Panama Canal."
Henry Goldmark, "Lock Gates, Chain Fenders and Lock Entrance Caissons."
H. F. Hodges, Brigadier General, U. S. A., "The General Design of the Locks, Dams and Regulating Works of the Panama Canal."
L. D. Cornish, "Design of the Lock Walls and Valves of the Panama Canal."
E. C. Sherman, "The Design of the Spillways of the Panama Canal."
T. B. Monniche, "Emergency Dams Above Locks of the Panama Canal."
R. H. Whitehead, "Hydraulics of the Locking Operations of the Panama Canal."

Irrigation

C. E. Grunsky, "Irrigation Enterprises in the United States."
F. H. Newell, "Economic Advisability of Irrigation."
J. S. Dennis, "Distribution Systems, Methods and Appliances in Irrigation."
Dr. Luigi Luiggi, "Italian Irrigation" and "Irrigation in Lybia (Italian Colony)."
Arthur P. Davis and D. C. Henny, "Dams."
G. E. P. Smith, "Utilization of Underground Waters."
M. Nethersole, "Irrigation in India."
William Lumisden Strange, "Earthen Dams."
Elwood Mead, "The Distribution of Water in Irrigation in Australia."
L. C. Hill, "The Co-Relation Between Demand and Supply, in View of the Variation Between Annual Demand and Supply from Natural Flow, Which Leads Up to a Study of the Amount of Storage Necessary."
J. C. Stevens, "Irrigation in Spain—Distribution Systems, Methods and Appliances."
J. C. Stevens, "Irrigation in Spain—Regulations Controlling the Use of Water, Metering Water for Irrigation and Methods of Charging."
Carlos Wauters, "The Problem of Irrigation in the Argentine Republic."
Samuel Fortier, "Duty of Water in Irrigation."
C. G. Elliott, "Drainage as a Correlative of Irrigation."

Municipal Engineering

Nelson P. Lewis, "City Planning."
Sir Albert Stanley, "London Traffic in 1913."
W. F. Reeves, "Transit Problems in American Cities."
J. W. Alvord, "Recent Progress and Tendencies in Municipal Water Supply in the United States."
Dr. E. Imbeaux, "Municipal Water Supply in France, Belgium, Algeria-Tunisia."
Rudolph Hering, "The Disposal of Suspended Matters in Sewage."
A. W. Bos, Director of Public Works, Amsterdam, The Netherlands, "Sewage for Low Countries with Special Regard to the Town of Amsterdam."
George W. Tillson, "Streets."
L. W. Page, "Rural Highways."
L. Limasset, Chief Engineer of Bridges and Highways, France, "Rural Highways."
Alfred Dryland, England, "Construction and Maintenance of Rural Highways."
Arthur Gladwell, England, "Rural Highways."
C. C. Dassen, Argentine Republic, "The Struggle Against Dust."
Dr. A. C. Humphreys, "Utilities."
Edward Willis, England, "Short paper on Public Utilities."
Dr. Ing. Fritz von Emperger, Austria, "Arch Bridges of Hopped Cast Iron."
Henry Welles Durham, "Preliminary Municipal Engineering at Panama."
George M. Wells, "Municipal Engineering and Domestic Water Supply in the Canal Zone."
Charles F. Mason, Lieutenant Colonel, Medical Corps, U. S. A., "Sanitation in Panama Canal Zone."
Dr. Luigi Luiggi, "'Boliditit' Concrete Roads in Italy."

Railway Engineering

F. Lavis, "The Status of the Railways of North and South America."
Dr. Luigi Luiggi, "Italian Railways."
Victor Bayley, "The Status of Indian Railways."
Charles Davis Jameson, "The Status of Chinese Railways."
V. A. Nagrodsky, "The Status of Russian Railways."
E. P. Wellenstein, "The Status of Railways and Tramways in the Netherland East Indies."
John F. Stevens, "Economic Considerations Controlling and Governing the Building of New Lines."
William Hood, "The Locating of a New Line."
Frederick Mears, "The Reconstruction of the Panama Railroad."
David Wilson, South Africa, "The Locating of a New Line."
Maurice E. Kernot, "Railway Construction Methods and Equipment in Australia."
J. E. Greiner, "American Railroad Bridges."
Charles S. Churchill, "Tunnels."
Dr. Luigi Luiggi, "Tunnels in Italy."
R. Winkler, "Tunnels in Switzerland."
George H. Pegram, "Track and Roadbed."
B. F. Cresson, Jr., "Railroad Terminals."
William Hood, "Electric Motive Power in the Operation of Railroads."
E. H. McHenry, "Electric Motive Power in the Operation of Railroads."
Charles Hansel, "Signals and Interlocking."

Materials of Engineering Construction

H. S. Betts and W. B. Greeley, "Structural Timber in the United States."
R. H. Campbell, "Timber in Canada."
R. S. Pearson, "Indian Timbers Used in Engineering Construction."
Mr. Tkachenko, "Timber in Russia."
Howard F. Weiss and Clyde H. Teesdale, "Preservative Treatment of Timber."
A. V. Bleininger, "Clay Products as an Engineering Material."
S. E. Thompson, "Aggregates for Concrete."
Bertram Blount, England, "Probable and Presumptive Life of Concrete Structures Made from Modern Cements."
Alfred H. White, "Volume Changes in Concrete."
Harrison S. Taft, "Use of Wood and Concrete in Structures Standing in Sea Water with Special Reference to Dock Work."
Prof. James Furman Kemp, "The Outlook for Iron."
J. A. L. Waddell, "Alloy Steels in Bridgework."
Thomas T. Read, "The Economics of the World's Supply of Copper."
Thomas T. Read and H. D. Hawks, "Consumption of Copper and Its Various Uses."
W. Reuben Webster, "Alloys and Their Use in Engineering Construction."
Prof. Joseph W. Richards, "The Engineering Uses of Aluminum."

Mechanical Engineering

H. D. Hinman and A. L. Bell, "Permanent Shops Pacific Terminals, Panama Canal."
Dr. H. Zoelly, London, "Developments in Modern Water Turbine Practice."
Arnold Pfau, "Water Wheels of Pressure Type."
J. D. Galloway, "Hydraulic Power Development and Use."
W. A. Doble, "Water Wheels of Impulse Type."
Charles H. Mitchell, "Canadian Hydraulic Power Development."
W. L. Saunders, "Compressed Air in the Arts and Industries."

Miscellaneous

George F. Swain, "Some Considerations Regarding Engineering Education in America."
Ira N. Hollis, "Technical Education for the Professions of Applied Science."

Electrical Engineering

H. F. Parshall, England, "Economics of Electric Power Station Design."
Sven Lubeck, "The Water Power of Sweden."
Charles H. Mitchell, "Electric Power in Canadian Industry."
Frank G. Baum, "The Effect of Hydro-Electric Power Transmission Upon Economic and Social Conditions, with Special Reference to the United States of America."
Edward Schildhauer, "Electrical and Mechanical Installations of the Panama Canal."
David B. Rushmore, "The Electric Motor as an Economic Factor in Industrial Life."

Mining Engineering

R. V. Norris, "Valuation of Anthracite Mines."
Samuel A. Taylor, "Valuation of Coal Lands."

Naval Architecture and Marine Engineering

F. H. Cooks, "Coaling Plants and Floating Cranes of the Panama Canal."
H. McL. Harding, "Cargo Handling Methods and of Appliances."
David B. Rushmore, "Some Economic Fundamentals of Freight Handling."
H. H. Rousseau, "Terminal Works, Dry Docks and Wharves of the Panama Canal."
W. F. Beyer, "Aids to Navigation of the Panama Canal."
Leonard M. Cox, "American Graving Dock Practice."
Dr. Luigi Luiggi, "Dry Docks Recently Built in Italy."

News of Engineering Societies

The Pacific Highway Association has changed the date of its annual convention to Sept. 16, so that it may co-operate in the work of the Pan-American Road Congress.

American Builders' Week at the Panama-Pacific International Exposition will be held at San Francisco, Oct. 18-23, under the management of the General Committee of the Building Industry of San Francisco.

The Arizona Association of Highway Engineers was organized at a meeting recently held at Flagstaff, Ariz. The Arizona State engineer, Lamar Cobb, was elected president and William H. Caruthers, county engineer of Maricopa County, secretary. Fourteen county engineers and several members of Mr. Cobb's staff were made charter members of the new organization.

The American Society of Sanitary Engineers held a special program at the Panama-Pacific International Exposition on Aug. 10, by way of supplement to the regular proceedings at the convention. The exposition presented the society with a commemorative medal, and at the conclusion of the program delegates assembled for a banquet at the Inside Inn as guests of Thomas J. Farrell, chief inspector of plumbing.

The Texas Good Roads Association held a joint meeting, Aug. 5 and 6, with the County Judges' and Commissioners' Association and the Texas Rural Carriers' Association, at the Agricultural and Mechanical College of Texas. James P. Nash, testing engineer of the Bureau of Economic Geology and Technology of the University of Texas, read a paper on "The Economic Road Materials of Texas," and there was a discussion of highway legislation led by A. N. Johnson of the New York City Bureau of Municipal Research.

Personal Notes

J. J. Woltmann has been appointed city engineer, of Anna, Ill.

W. S. Franklin has resigned from the professorship of physics at Lehigh University.

G. E. Byars, recently city engineer of Waco, Tex., has been appointed superintendent of buildings and grounds at the Agricultural and Mechanical College of Texas.

Chester & Fleming, engineers, of Pittsburgh, have been engaged to take charge of the operation of the plant of the Upper Sandusky (Ohio) Waterworks Company.

George J. Davis, Jr., dean and professor of civil engineering at the University of Alabama, has been retained to prepare plans for a municipal wharf at Tuscaloosa, Ala.

Albert Freitag, civil engineer, of Grand Island, Neb., has closed his office in that city to accept an appointment on the engineering forces of the Little Rock Drainage District, at Whitewater, Mo.

L. N. Hintgen has been appointed acting assistant city engineer of Sioux City, Iowa. He was formerly connected with the M. L. Thrim Paving Company of Sioux City and, previous to that, was connected with the city engineer's office.

W. E. Dozier, formerly chief engineer and general superintendent of the Northwestern & Gulf Railway and, previous to that, city engineer of Temple, Tex., has been appointed engineer in charge of street paving at Taylor, Tex.

Jerome Newman, assistant State engineer in charge of Harbor Work with headquarters at San Francisco, has been appointed chief engineer of the State Board of Harbor Commissions by the advisory board of the Engineering Department.

R. L. Sanders, formerly with the American Society of Civil Engineers, assisting in the determination of railroad track stresses, under Prof. A. N. Talbot, at Champaign, Ill., has been appointed resident engineer on the forces of the State Highway Commission of Illinois.

M. J. Cronin, formerly chief draftsman in the division engineer's office of the Delaware, Lackawanna & Western Railroad at Binghamton, N. Y., has been engaged to prepare maps for Federal valuation in the chief engineer's office of the Buffalo, Rochester & Pittsburgh Railway at Rochester.

George C. Stone, engineer for Lockwood, Green & Company, architects and engineers for industrial plants, of Boston, Mass., is representing that firm in Buffalo, N. Y., during the erection of the eleven story and basement reinforced-concrete warehouse, which is being built in that city for the Walker Building Corporation.

Arthur M. Torrey, who for the past four years has been in charge of the soliciting department of Hildreth & Company, engineers, 15 Broad Street, New York City, has resigned from that position to take charge of the engineering contract department of W. S. Barstow & Company, engineers and managers, 50 Pine Street, New York City.

R. G. Jones, assistant division engineer on the northern division of the Grand Rapids & Indiana Railroad, has been made division engineer of the southern division at Fort Wayne, succeeding C. L. Barnaby, who has been transferred to Grand Rapids. Mr. Jones has been engaged in railroad civil engineering for the past thirteen years.

The Robertson Engineering Company, of San Antonio, Tex., has taken over the engineering practice of E. A. Kingsley, whose appointment as paving engineer of the city of San Antonio was noted in these columns, July 17. Mr. Lake Robertson, who was associated with Mr. Kingsley, and who has had entire charge of his paving work at Temple, Tex., will be the head of the Robertson Company.

Gardner S. Williams, consulting engineer, Cornwell Building, Ann Arbor, Mich., has opened an office in the Corn Exchange Bank Building, Chicago, for consultation, designing and supervision of construction, in hydraulics, hydroelectric development, water power and water supply. Associated with Mr. Williams are: R. K. Holland, G. E. Ackerman, H. K. Holland, A. E. Greene and L. E. Ayres.

Robert Coe, formerly connected with the Carnegie Steel Company at Pittsburgh, has joined the forces of the International Nickel Company at Copper Cliff, Ont. His first engineering service was on the forces of the Norfolk & Western Railroad, from 1886 to 1894. From 1895 until 1907 he was with the U. S. Geological Survey, and, from 1907 to 1909, with the Isthmian Canal Commission. He entered the service of the Carnegie Steel Company in 1910.

Charles B. Cornell, formerly division engineer of the reservoir division on the waterworks improvements at Akron, Ohio, has accepted the position of resident engineer on the improvement of sewage treatment at Columbus, Ohio, for which J. J. Morgan of Columbus, is consulting engineer. Mr. Cornell received his engineering education at Ohio State University and has had considerable experience in the design and construction of sewer systems, sewage disposal plants and waterworks, mostly in Ohio and Indiana.

L. V. Reese, who recently completed a contract for constructing a system of block maps for the city of Tyler, Tex., has opened an office at Hamilton, Tex., for the purpose of practising as a civil and contracting engineer. His first engagement along engineering lines was as assistant to V. M. Ehlers, who is, at present, State sanitary engineer of Texas, on municipal and sanitary work. In 1912 he became associated with the McCoombs Engineering Company of Waco on the construction of railroads, levees, sewerage systems and waterworks. In 1913 he severed his connection with this company to accept a position in connection with the Federal valuation work on the St. Louis Southern Railroad. He left that work in the early part of the present year to construct the system of block maps for the city of Tyler.

Louis C. Fritch, assistant to the president of the Canadian Northern Railway at Toronto, Ont., has been appointed general manager of the lines east of Port Arthur in addition to his present duties. He received his engineering education at the University of Cincinnati and entered railway work in 1884 as supervisor's assistant on the Ohio & Mississippi. In 1886 he was appointed assistant engineer and served in that capacity until 1892 when he was appointed engineer maintenance-of-way. In 1893 he became a division engineer on the Baltimore & Ohio Southwestern and, in 1889, was appointed superintendent of the Mississippi division of that road. He went to the Illinois Central in 1904 and became assistant to its general manager in 1905. He was appointed assistant to the president in 1906 and consulting engineer in 1909. Later he was appointed chief engineer of the Chicago Great Western. He was appointed assistant to the president of the Canadian Northern in 1914.

Lorenzo C. Dilks, formerly connected with the Eastern Steel Company, has been elected president and general manager of Milliken Brothers of New York City, manufacturers and erecters of all classes of structural steel, including bridges, buildings and power transmission lines. Mr. Dilks' first engagement along engineering lines was as draftsman in the bridge and construction department of the Pencoyd Iron Works from 1892 to 1897. In this capacity he assisted in the design of a proposed railroad bridge for the Long Island Railroad over the East River at Blackwell's Island, New York City, and on the company's design for a proposed bridge over the St. Lawrence River at Quebec. He also had charge of making detailed shop drawings for a large portion of the arch bridge over the Niagara River between Niagara Falls, N. Y., and Clifton, Ont. In the fall of 1897 he was with L. L. Buck on the design and estimates for the Connecticut Avenue Bridge over Rock Creek at Washington, D. C. Then, after a short period in the engineer's office of the Williamsburg Bridge, New York City, he returned to the Pencoyd Iron Works, for which company he served as engineer on the erection of the New York Central & Hudson River Railroad passenger bridge over the Hudson River at Albany, N. Y. From 1900 to 1901 he was in the office of C. C. Schneider, vice-president of the American Bridge Company, and, from May of the latter year to 1903 served as one of the assistants to Alfred J. Major, president of the company. From 1903 to 1904 he was manager of its Buffalo plant. He was appointed contracting engineer for the Belmont Iron Works of Philadelphia in 1904 and contracting manager of the Eastern Steel Company in 1905.

Obituary Notes

Dennis Hayes, capitalist and contractor, died at Janesville, Wis., Aug. 10. Mr. Hayes built the Lockport dam on the Chicago Drainage Canal.

Arthur R. Pardington, vice-president and secretary of the Lincoln Highway Association, died in Detroit, Aug. 2.

Civil Service Examinations

United States.—An open competitive examination for an assistant irrigation engineer, salary from $1,000 to $1,500 a year, is announced for Sept. 22, to be held at the usual places. The duties of this position will be to investigate methods of preparing land and applying water in farm irrigation, measurement and delivery of water, irrigation channels and structures, design, installation and operation of pumping plants, and regulations and laws relating to irrigation. Applicants must have either four years' experience in civil engineering or a technical school education. Further information may be secured by applying for form 1312, stating the title of the examination, to the U. S. Civil Service Commission, Washington, D. C., or to civil service boards at the principal cities of the country.

New York.—The Civil Service Commission announces an examination for lock operator, salary from $901 to $1,200 a year, to be held Sept. 18. Candidates must be 23 years old and must have three years' experience in the erection and operation of electrical machinery in either substations or power plants. Application blanks for this examination will not be received after Sept. 8, nor will they be distributed by mail after Sept. 6. Application should be made to the Civil Service Commission, Albany, N. Y.

Philadelphia.—Notice of an examination for an assistant examiner, civil engineer, salary $1,800 a year, to be held in the near future, is made public. The duties are primarily those of an instructor for the Civil Service Commission. The requirements to compete are graduation from an engineering institution and some practical experience. Applicants must be 23 years of age and residents of the State. In applying for a form the title of the position for which it is desired should be given. All forms must be properly executed and filed with the commission, Room 875, City Hall, Philadelphia, by Sept. 11.

Examinations Previously Announced

Date		See Eng. Record
Aug. 25-26	Junior civil engineer, Engineering Department, United States	July 31
Sept. 15	Aid, U. S. Coast and Geodetic Survey; draftsman and junior engineer, U. S. Engineer Department	July 3
Oct. 13	Aid, U. S. Bureau of Standards; civil engineer and draftsman, draftsman, Navy Department; engineer, Indian Service	July 3